Edvation

Advancing education for
21st century success.

Research Base

9 Lake Bellevue Dr. #105
Bellevue, WA 98005
Tel: 425-454-3373 Fax: 425-467-0580
Email: service@edvation.com

Table of Contents

Introduction	**3**
- The Edvation Products	
Chapter 1 - Research on Learning	**7**
- On Learning and Context	9
- On Learning and Collaboration	11
- On Learning and Prior Knowledge	15
- On Learning and Reflection	17
- On Learning and Scaffolds	19
- On Learning and Higher -Order Thinking	21
Chapter 2 - Research on Technology and Learning	**23**
- On Technology and Active Learning	25
- On Technology and Higher-Order Thinking	29
- On Technology and Problem Solving	33
- On Technology and Student Achievement	37
- On Technology and Student Attitudes	41
- On Technology Integration	45
- On Technology and Learner Productivity	49
Chapter 3 - Principles for Technology Integration	**51**
- Edvation Technology Integration Principles for English Language Arts	53
- Edvation Technology Integration Principles for Mathematics	55
- Edvation Technology Integration Principles for Science	57
- Edvation Technology Integration Principles for Social Studies	59

Introduction

Edvation develops and provides products and services that help teachers to integrate technologies into the instructional process to benefit student learning.

Just as we know that paint and paint brushes do not make a painting, we understand that technology, per se, does not lead to learning. Many years of educational research, however, have proven certain instructional practices that lead to sound learning and student achievement. And recent findings show that there are ways in which technology can be applied to effectively facilitate and sometimes enhance these practices. Edvation uses this research base - much of it scientific in nature - to guide both content development and pedagogy so that its products can be used by professional educators to improve student achievement in mathematics, science, English language arts, and social studies.

Here is a simple example. Research demonstrates that there is value in history students using primary sources. Research also shows that certain technologies can make quality primary sources more accessible to students. An Edvation product may help a teacher to identify standards-based lesson objectives, and then design a learning experience in which students locate, select, and analyze digitized primary sources to achieve those objectives.

It is easy to see in the example above, how, through this process, history students would also be developing 21st century skills. As notions of information literacy and lifelong learning continue to evolve, school systems are ensuring that their curriculum remains relevant both in terms of what students learn, and how students learn. To a greater or lesser extent, these new requirements are woven through existing curriculum standards and/or documented separately. Drawing upon the aforementioned research on learning and learning technologies, Edvation resources help teachers to weave 21st century skills into the lesson design process to strengthen the overall learning experience and the associated outcomes.

Overview

To help readers understand how Edvation incorporates research findings into its products, this book is presented in three sections:

Chapter 1 presents 'Research on Learning.' Research shows that when certain 'qualities' are part of the learning experience, there are clear benefits to students (such as increased comprehension and deeper conceptual understandings) which in turn leads to measurable improvements in academic achievement as may be shown by increased test scores. Edvation identifies and labels these qualities and aligns them with instructional strategies that can bring these qualities into the learning experience. Edvation's instructional design is built upon these research-proven instructional strategies.

Chapter 2 presents 'Research on Technology and Learning.' A number of research studies have examined aspects of educational technology use that were found to result in measurable benefits to learners. Again, Edvation aligns these aspects with both macro- and micro-instructional strategies.

Chapter 3 presents Edvation's own, proprietary 'Principles for Technology Integration.' These principles are based upon meta-research including the findings presented in Chapters 1 and 2. These are the principles that Edvation uses in its own instructional design processes. Edvation's 'Principles for Technology Integration' succinctly frame aspects of technology that can be used to facilitate desired learning processes in the study of English language arts, mathematics, science, and social studies.

The TechSteps Product

TechSteps is an integrated technology literacy curriculum and assessment tool. Students learn technology skills systematically as they work through meaningful mathematics, science, language arts, and social studies activities. The content of the activities can be adapted to suit individual teaching contexts. Each TechSteps learning activity reflects Edvation's instructional design methodology which is built upon this research base. Skills are assessed by the teacher using rubrics that guide student performance. These rubrics are tied to technology literacy standards and provide data about each student’s ongoing development towards technology literacy. TechSteps, then, offers school districts a complete and flexible way to manage and assess K-8 technology literacy development.

The pd21 Product

pd21 is an online professional development solution that helps teachers to design and implement their own sound technology integration lessons. All pd21 workshops are designed under the umbrella of Edvation's research-based 'Principles for Technology Integration' (see above). As each pd21 workshop, however, deals with specific methodologies, the theoretical component of each workshop presents additional research validating the methodologies being discussed.

For example, the following is a small excerpt from the Introduction of the workshop called 'Create a Video Essay.'

> *Polin, in The Multimedia Essay, "concurs with other research findings that 'designing is thinking,' and that 'when knowledge is connected to purpose, it transforms from static information to active application of understanding' " (qtd. in NCIP). As students grapple with design decisions - carefully choosing multimedia materials to fulfill specific informational and aesthetic functions - they may clarify and confirm their own understandings and attitudes about a topic.*

NCIP. Library Collection: Multimedia. http://www2.edc.org/NCIP/library/mm/Polin.htm

Polin, L. "The Multimedia Essay or Designing is Thinking." The Writing Notebook, 8:4 (1991), 27-29.

Chapter 1

Research on Learning

Research shows that when certain 'qualities' are part of the learning experience, there are clear benefits to students (such as increased comprehension and deeper conceptual understandings) which in turn leads to measurable improvements in academic achievement as may be shown by increased test scores. Edvation identifies and labels these qualities and aligns them with instructional strategies that can bring these qualities into the learning experience. Edvation's instructional design is built upon these research-proven instructional strategies.

Research Finding

ON LEARNING AND CONTEXT

When tasks are based within a relevant context, student problem solving strategies are more effective and comprehension is increased.

Research Evidence

"Instruction should be anchored in meaningful contexts that allow situated learning to be simulated in the classroom. In this way, environments can be designed that allow sustained exploration of the various aspects of a problem, helping students to understand the kinds of problems and opportunities that experts in various areas encounter and the knowledge that these experts use as tools" (Cognition and Technology Group at Vanderbilt University qtd. in Orey and Nelson).

"Provide authentic contexts that reflect the way knowledge will be used in real-life, that preserve the full context of the situation without fragmentation and decomposition and allow for the natural complexity of the real world. For example, instead of simplifying the content of a program by breaking it up into tasks and sub-tasks, place it in a complex real-world situation which provides opportunity for the learner to decide what is important. The complexity should allow the learner to detect both relevant and irrelevant materials" (Herrington and Oliver).

"Individuals assume responsibility for establishing and monitoring their goals and strategies when the reasons for performing procedures […] are understood within the context of a broad global tasks environment" (Honebien, Duffy and Fishman in Lebow and Wager).

"Increasingly, theorists and educators are promoting reality-centered projects, theme-based learning, and other kinds of activities situated in real-life and life-like contexts as ways to engage students in meaningful learning" (Blumenfeld, et al., Clinchy, Wager in Lebow and Wager).

From Research to Practice

A number of pedagogical strategies emphasize the use of relevant context in student tasks. These strategies include: conducting interviews and surveys, creating realistic models and simulations, working with primary sources and case studies, and providing authentic problem solving situations. The instructional design of Edvation content incorporates these strategies where they will add value to the learning experience.

Recognizing that knowledge consists of items that exist in relation to each other rather than independently, Edvation activities employ a meaningful context that, wherever possible, reflects how the knowledge is used in real life. For example, each of Edvation's edClass student activities begins with an introductory challenge that in many cases provides a problem-solving situation that serves as a framework for the learning experience. In other activities, the student outcome is in itself an authentic task that is commonly used in the real world, such as the designing of a model or the conducting of a survey.

Skills like latitude and longitude are often taught out-of-context. In Edvation's *A Nautical Adventure*, however, these skills are wrapped in a meaningful and motivating scenario - the student must take over the navigation of a ship in an emergency situation. As the activity continues, the student uses a variety of practical, but integrated skills that include such tools as the use of the Internet to track ships using a map, and Excel to efficiently calculate distances.

In the activity, *Online Volunteering*, high school students are given the chance to explore virtual volunteer opportunities and work as a group to solve a real-life service situation. This problem solving experience takes students out of the classroom as they solve real-world challenges.

As part of a series called *The Information Process*, students are given the guidelines to set up interviews as part of the gathering information stage. In the *Research Process* activity series, students are asked to create and conduct an opinion survey to collect, organize, and analyze their own data. Both these activities emphasize the importance of providing students with the tools they need to add relevant and meaningful context to their research projects - in this case - utilizing human resources.

Works Cited

Herrington, Jan, and Ron Oliver. "What Situated Learning Tells Us About the Design of Multimedia." Learning Without Limits. Ed. R. Oliver and M. Wild. Claremont: Educational Computing Association of Western Australia, 1996.

Lebow, David and Walter Wager. Authentic Activity as a Model for Appropriate Learning Activity: Implications for Design of Computer Based Simulations. Nashville: Association for Educational Communications and Technology, 1994.

Orey, Michael and Wayne Nelson. Situated Learning and the Limits of Applying These Data to the Theories of Cognitive Apprenticeships. Nashville: Association for Educational Communications and Technology, 1994.

Related Reading

Herrington, Jan, and Ron Oliver. Critical Characteristics of Situated Learning: Implications for the Instructional Design of Multimedia. Perth: Edith Cowan University, 1995.

Research Finding

ON LEARNING AND COLLABORATION

Student understanding is increased when students are given opportunities to collaborate with others.

Research Evidence

"Opportunities for peer discussion and response build community and enhance understanding for all kids in the class" (Harvey and Goudvis).

"Individual accountability is important, but students' engagement in the learning process can be enhanced by allowing them to work in pairs or small groups on activities that require sharing and meaningful interactions. Students are more receptive to challenging assignments when they can put their heads together rather than work in isolation. Collaborative work also can help students develop skills in cooperation. Furthermore, it helps create a community of learners who have responsibility for each other's learning…" (Cohen in BOCYF).

"Teachers must attend to designing classroom activities and helping students organize their work in ways that promote the kind of intellectual camaraderie and the attitudes toward learning that build a sense of community. In such a community, students might help one another solve problems by building on each other's knowledge, asking questions to clarify explanation, and suggesting avenues that would move the group toward its goal" (Brown and Campione in Donovan, Bransford, and Pellegrino).

"What children can do with the assistance of others is even more indicative of their mental development than what they can do alone" (Vygotsky in Bransford, Brown, and Cocking).

From Research to Practice

A number of pedagogical strategies have been shown to promote meaningful collaboration. These include: forming learning groups with defined roles, allowing student-led class discussions, encouraging peer tutoring and assessment, participating in cooperative games and using the Internet as a form of interaction with others. The instructional design of Edvation content incorporates these strategies where they will add value to the learning experience.

Collaborative opportunities are built-in to Edvation content in various ways. In a general sense, most of the activities are flexible and open-ended; thereby allowing teachers to have students use the resources as they operate collaboratively and/or in organized co-operative groups. Most of the tasks, for example, require that students build their own information products as they construct knowledge and demonstrate their understandings. These tasks can easily be presented as team projects.

Other Edvation content incorporates collaborative learning in more explicit ways, including: activities that include teacher tips suggesting how the task can be presented as group work; activities where group work - including discussion and collaboration - is an integral part of the lesson; activities where students are required to play different roles; and activities that require students interact with, and collect data from others (perhaps using the Internet).

In *Play with Pentominoes*, after constructing a set of 12 unique pentominoes (shapes made of five squares), students are required to pair-up and use their pentominoes to play a strategy game that reinforces the concepts learned earlier in the activity. Our testing has shown that this encourages students to verbalize their mathematical thinking (they use new terms such as reflect and rotate), and to teach each other.

In *Classification of Rocks*, students first perform individual research and then combine their research to produce a shared central database. The strength of this activity is in the strategy of allowing students to validate and build upon the work of each other. The task itself requires interpersonal negotiation and students see that the increased amount and quality of data collected leads to a better analysis.

The Internet has opened up another aspect to the idea of collaboration. In *Genetic Traits*, elementary students compare genetic traits with classmates and then are able to access a university database and contribute their results as part of an online project. In *Online Book Review*, high school students have the opportunity to read online book reviews, then write and post their own work online to share with a reading community worldwide.

Works Cited

Board on Children, Youth and Family. Engaging Schools: Fostering High School Students Motivation to Learn. Washington DC: The National Academy of Science, 2003.

Bransford, John, Ann L. Brown, and Rodney R. Cocking, eds. How People Learn: Brain, Mind, Experience, and School. Washington DC: National Academy Press, 2000.

Donovan, Suzanne, John D. Bransford, and James Pellegrino, eds. How People Learn: Bridging Research and Practice. Washington DC: National Academy Press, 2000.

Harvey, Stephanie, and Anne Goudvis. Strategies that Work: Teaching Comprehension to Enhance Understanding. Portland: Stenhouse Publishing, 2000.

Related Reading

Kluge, David. "A Brief Introduction to Cooperative Learning." Cooperative Learning. Japan: JALT Applied Materials, 1999.

Lee, Christine, et al. Cooperative Learning in the Thinking Classroom: Research and Theoretical Perspectives. Singapore: International Conference of Thinking, 1997.

Webb, James. Benefits of Cooperative Learning in Multimedia Environment. Carbondale: Southern Illinois University, 2002.

Research Finding

ON LEARNING AND PRIOR KNOWLEDGE

By activating and building on prior experiences, students' comprehension is improved.

Research Evidence

"The learner is actively constructing knowledge rather than passively taking in information. Learners come to the educational setting with many different experiences, ideas, and approaches to learning. Learners do not acquire knowledge that is transmitted to them: rather they construct knowledge through their intellectual activity and make it their own" (Chaille and Britain qtd. in Jaeger and Lauritzen).

"Learners try to link new information to what they already know in order to interpret the new material in terms of established schemata" (Resnick, qtd. in CSMEE).

"Learners are not blank slates. The learning process must build on prior experiences and knowledge. For this to take place, learning situations must provide opportunities for students to articulate and represent their knowledge" (Osterman).

"As a whole, the research base provides good evidence to support the use of prior knowledge activation strategies; prior knowledge activation is regarded as a research-validated approach for improving children's memory and comprehension of text" (Pressley et al. in Strangman and Hall).

"All learning involves transfer from previous experiences. Even initial learning involves transfer that is based on previous experiences and prior knowledge" (Bransford, Brown, and Cocking).

From Research to Practice

A number of pedagogical strategies have been shown to activate students' prior knowledge. These include: conducting meaningful class discussions and brainstorm sessions, using graphic organizers and concept maps, encouraging the use of learning logs, and allowing reflection time. The instructional design of Edvation content incorporates these strategies where they will add value to the learning experience.

Edvation recognizes that learners build upon prior knowledge and create relationships between items of knowledge that form personal understandings of the world. Edvation products encourage active learning by using design techniques like providing reflection opportunities and posing discussion questions before, during and after the activity. Edvation activities allow teachers to not only connect information from past to present learning in a way that is meaningful for students, but to also inform them about possible student misconceptions so appropriate points of entry can be determined for new topics that build on what students already know.

Edvation activities like *KWLH Organizer* specifically deal with prior knowledge activation - students are introduced to a way to organize their learning into categories of what they know, want to know, what they learn and how they can continue to learn about a topic.

In the introduction of many of the activities, like *Fact and Fiction Habitat*, discussion questions are included that will help a teacher evaluate a students' current understanding of the concepts involved. In this case, students discuss their definition, concept and experience of a habitat before they start the activity.

Works Cited

Bransford, John, Ann L.Brown, and Rodney R. Cocking, eds. How People Learn: Brain, Mind, Experience, and School. Washington DC: National Academy Press, 2000.

Center for Science, Mathematics, and Engineering Education. "How Children Learn." Science for all Children. Washington DC: National Academy for the Sciences Press, 1997. 22-33.

Jaeger, Michael, and Carol Lauritzen. The Construction of Meaning from Experience. Louisville: National Council for Teachers of English, 1992.

Osterman, Karen. Using Constructivism and Reflective Practice to Bridge the Theory/Practice Gap. San Diego: American Educational Research Association, 1998.

Strangman, Nicole, and Tracey Hall. Background Knowledge. Wakefield, MA: National Center on Accessing the General Curriculum, 2004. <http://www.cast.org/publications/ncac/ncac_backknowledge.html>.

Related Reading

Dangel, Julie, and Edi Guton. "An Emerging Picture of Constructivist Teacher Education." The Constructivist. 15.1. (2004)

Jones, Annette, Nelly Todorova, and John Vargo. Improving Teaching Effectiveness Understanding and Leveraging Prior Knowledge for Student Learning Brisbane: International Academy for Information Management Annual Conference, 2000.

Murphy, Elizabeth. Constructivism: From Philosophy to Practice. United States Department of Education, 1997.

Research Finding

ON LEARNING AND REFLECTION

Incorporating reflection into the learning process leads to increased conceptual understanding.

Research Evidence

"The reflection is the pause in the act of learning that deepens understanding and gives meaning to the learning. [...] The reflection gives students time to scrutinize, observe, and question. In the reflective phase of learning, the mind sorts and synthesizes, rearranges and reconnects" (Fogarty qtd. in Bell).

"[Reflective thinking involves] (1) a state of doubt, hesitation, perplexity, mental difficulty, in which thinking originates, and (2) an act of searching, hunting, inquiring, to find material that will resolve the doubt, settle and dispose of the perplexity" (Dewey 12).

Reflection is a critical aspect of all sophisticated and higher-order thinking and learning. ...As we become more aware of the experiential nature of learning, it will become more important for students to reflect on their experiences to adequately grasp the implications" (Caine, R. & Caine, G. qtd. in Bell).

"In reflection we attempt to understand something by explaining it to ourselves. Explaining something to oneself means, in essence, attempting to correct an initial lack of understanding or misunderstanding by finding relevant experiences in one's memory that might account for the incomprehensible event. In other words, explanation, learning, problem solving and also creativity, are inextricably bound together" (Rowe).

"The types of tools that scaffold students' reflective thinking, such as reflective journal writing, guiding questions, and concept maps are important in fostering students' reflective thinking" (Kinchin and Hay; Koszalka et al. in Kim).

From Research to Practice

A number of pedagogical strategies have been shown to promote student reflection. These include: using journals and learning logs, conducting class discussions, allowing for personal learning styles, i.e. expression through sketching or poetry, and encouraging peer sharing. The instructional design of Edvation content incorporates these strategies where they will add value to the learning experience.

Edvation lessons encourage an environment that facilitates students to reflect upon their learning. Depending on lesson content, reflection can be designed into learning experiences through instructional techniques such as prompting learners to ask questions, examine their own methodologies, discuss their thoughts with peers, or reflect upon completed activities. Structuring Edvation products to encourage student reflection allows learners to stand back and take time to consider what they know and what they are learning in order to form new mental models and understandings.

In the activity, *Describe Planets with Venn Diagrams*, reflection is used throughout the lesson. In the introductory section, *Sharing What You Know*, students are first asked to think about the ways they can show someone what they have learned. During the *Think* time, students are directed to reflect upon how a diagram would change if different comparison data was used. Finally, after completing the activity, an extension challenge gives students the chance to think about other subjects that they could explore using Venn diagrams.

The activity, *Write a Personal Response Page*, students are challenged to write a personal response to a favorite book. Then, in an extension, they are introduced to the idea of a 'metacognitive' response page that allows them to become more aware of themselves as a reader.

Works Cited

Bell, Annette. Creating an Enriched Emotional Environment. New York:Tompkins Cortland Community College Dialogue on Learning Project, 1998.

Dewey, John. How We Think: A Restatement of the Relation of Reflective Thinking to the Educative Process. Lexington: D.C. Heath, 1933.

Kim, Kyoungna, Barbara Grabowski and Priya Sharma. Designing a Classroom as a Learner-Centered Learning Environment Prompting Students' Reflective Thinking in K-12. State College: Penn State University, 2003.

Rowe, Helga. "Computer-Assisted Knowledge Acquisition." Australian Educational Computing Journal 10.1(1995).

Related Reading

Barton, Valerie, et al. Metacognition: Effects on Reading Comprehension and Reflective Response. Chicago: Saint Xavier University, 2001.

Caine, Renate, and Geoffrey Caine. Making Connections: Teaching and the Human Brain. Alexandria: Dale Seymour Publications, 1994.

Fogarty, Robin. Brain-Compatible Classrooms, 2nd ed. Thousand Oaks: Corwin Press, 2001.

Reimers, Valerie. Students Writing About Their Writing as Reflection. Conference on College Composition and Communication. Phoenix: Arizona, March 1997.

Rimor, Rikki, and Ely Kozminsky. Learners' Reflections in Technological Learning Environments: Why to Promote and How to Evaluate. Society for Information Technology and Teacher International Conference. Volumes 1-3 (2000).

Research Finding

ON LEARNING AND SCAFFOLDS

The use of scaffolded instructional strategies increases student comprehension of tasks and enables them to assume responsibility for skills in future learning.

Research Evidence

"Inherent in scaffolded instruction is Vygotsky's (1978) notion of the zone of proximal development. Vygotsky defined this zone as '… the distance between the actual development level as determined by independent problem solving and the level of potential development as determined through problem-solving under adult guidance or in collaboration with more capable peers.' […] As stated in Reid (1991), implicit in the idea of scaffolded instruction is that the teacher enables learners to participate in complex tasks that they can't perform adequately without assistance" (Ellis, Worthington and Larkin).

"[As a way to help meet the challenge of establishing effective learning environments] scaffolding support augments what learners can do and reason about on their path to understanding. Scaffolding allows learners to participate in complex performances, such as scientific visualization and model-based learning, that is more difficult or impossible without technical support" (Bransford, Brown, and Cocking).

"Teachers must employ a range of sophisticated facilitative strategies to support individual students' understanding as they engage in the problem-solving activities that characterize constructivist classrooms. These strategies include: scaffolding - in which the task required of the learner is strategically reduced in complexity, modeling - in which the teacher either thinks aloud or acts out how she would approach a problem, and coaching/guiding/advising - which are loosely defined as providing prompts, probes, or suggestions to learners at varying degrees of explicitness" (Choi and Hannafin in Windschitl).

"Scaffolding is one of the principles of effective instruction that enables teachers to accommodate individual student needs" (Kame'enui et al. in Larkin).

"Students can become independent, self-regulated learners through instruction that is deliberately and carefully scaffolded" (Ellis, Worthington and Larkin).

From Research to Practice

A number of pedagogical strategies have been shown to support the use of scaffolds in the classroom. These include: modeling or demonstrating by a teacher or peer, structuring guided practice, utilizing templates, graphic organizers and concept maps, allowing peer tutoring and supporting an apprenticeship learning model. The instructional design of Edvation content incorporates these strategies where they will add value to the learning experience.

Edvation knows that students need to be guided and supported, but not in such a way that makes a task automatic. Before designing an activity, Edvation designers identify the project's components so areas where learners may have difficulties can be identified. In doing this, scaffolding strategies can be determined that will address the different areas of concern. Well-sequenced content, materials, and tasks along with teacher and peer support goes a long way towards helping students to eventually become independent problem solvers, but Edvation also utilizes other design structures , such as templates and informative pop-ups.

In *Play with Tangrams*, pop-up tips are used - "If you need help tips" - that give visual hints on how to put together the shapes if a student needs support in the task. Throughout Edvation activities, students (and teachers) can choose whether or not to access pop-ups for additional support or hints.

Another scaffolding technique - the guidance template - is often employed in Edvation activities. For example, experience has shown that students can be overwhelmed in setting up the structure of a nonlinear story. In *Choose Your Own Adventure,* Edvation provides a model planning document and a guidance template so students are able to concentrate on the content of the story and learn how to successfully design their own story in the future.

Works Cited

Bransford, John, Ann L. Brown, and Rodney R. Cocking, eds. How People Learn: Brain, Mind, Experience, and School. Washington DC: National Academy Press, 2000.

Ellis, Edwin, Lou Anne Worthington, and Martha Larkin. Executive Summary of the Research Synthesis on Effective Teaching Principles and the Design of Quality Tools for Educators. Tuscaloosa: University of Alabama. <http://idea.uoregon.edu/~ncite/documents/techrep/tech06.html>.

Larkin, Martha. Using Scaffolded Instruction to Optimize Learning. Arlington: Disabilities and Gifted Education, 2002.

Windschitl, Mark. The Pedagogical, Cultural, and Political Challenges of Creating a Constructivist Classroom. Seattle: International Congress on Personal Construct Psychology, 1997.

Related Reading

Flick, Lawrence. Teaching Practices That Provide Cognitive Scaffolding for Classroom Inquiry. Corvallis: Oregon State University, 1998.

Marsh, George, and John Ketterer. Situating the Zone of Proximal Development. Carrollton: University of West Georgia, 1982

Murphy, Elizabeth. Constructivism: From Philosophy to Practice. United States Department of Education, 1997.

Research Finding

ON LEARNING AND HIGHER-ORDER THINKING

Comprehension is increased when students are presented with learning opportunities that require higher-order thinking skills such as solving problems, making decisions and analyzing data.

Research Evidence

"[Higher-order thinking occurs] when a person, interprets, analyzes, evaluates, synthesizes and organizes information because the problem to be solved or the question to be answered cannot be handled by routine retrievals or algorithmic applications of previously acquired information" (Newmann, qtd. in Stratton).

"Critical thinking is the intellectually disciplined process of actively and skillfully conceptualizing, applying, analyzing, synthesizing, and/or evaluating information gathered from, or generated by, observation, experience, reflection, reasoning, or communication, as a guide to belief and action" (Paul and Scriven).

"Higher order thinking happens, not because teachers teach kids how to do it, but because teachers are able to raise issues so vital, so thought-provoking, and so connected to the real world, that kids are challenged to make meaning from them and to find out what they need to know beyond what is presented by the teacher" (Stratton).

"Critical thinking is a superior way of processing experiences by getting meaning out of the experience and putting meaning back into it" (Lipman).

"Research on learning shows that students become cognitively engaged when they are asked to wrestle with new concepts, when they are pushed to understand - for example, by being required to explain their reasoning, defend their conclusions, or explore alternative strategies and solutions" (National Research Council qtd. in BYCOF).

From Research to Practice

A number of pedagogical strategies have been shown to encourage higher order thinking. These include: utilizing open-ended problem solving, requiring products from all levels of Bloom's Taxonomy, and varying questioning techniques and purposes. The instructional design of Edvation content incorporates these strategies where they will add value to the learning experience.

The design of the Edvation activities encourages a classroom shift away from memorizing facts to helping students to deal with ideas and acquire personal knowledge. Edvation activities provide a learning environment that promotes higher-order thinking by using techniques such as asking open questions, presenting issues that need to be explored, and requiring learners to make decisions and contributions.

The typical edClass activity presents students with a Challenge that sets up a problem solving situation. For example, in *A Town in Time,* students create a series of slides that represent a town at different points of history. However, the lesson leads them to discover not just what changes as a town develops, but why those changes occur. As the activity unfolds, students are given opportunities to compare and analyze town representations, create their own developing town, and predict factors that influence city development.

In the book 'Ray's Electricity Calculator,' an Excel model assists students to be become involved in developing a strategy for electricity conservation. Students first explore how the daily cost of Ray's electricity is affected by his variable use of a number of appliances. They then build their own model that shows their current consumption of electricity and how it might be reduced.

Works Cited

Board on Children, Youth and Family. Engaging Schools: Fostering High School Students Motivation to Learn. Washington DC: The National Academy of Science, 2003.

Lipman, Mathew. "Misconceptions in Teaching for Critical Thinking." Resource Publication, Series 2.3. Montclair: Institute for Critical Thinking, 1989.

Paul, Richard, and Michael Scriven. Defining Critical Thinking. Dillon Beach: National Council for Excellence in Critical Thinking, 2004.

Stratton, Jean. "Helping Kids to Probe and Ponder: Integrating Higher Order Thinking into the General Curriculum." Curriculum Reform Project Report. Washington, DC: Office of Educational Research and Improvement, 1992.

Related Reading

Gusky, Thomas. Benjamin S. Bloom's Contributions to Curriculum, Instruction and School Learning. Seattle: Educational Research Association, 2001.

Kelder, Richard. Epistemology and Determining Critical Thinking Skills in the Disciplines. Montclair: Institute for Critical Thinking, 1992.

Leshowitz, B., K. E. DiCerbo, and S. Symington. "Effective Thinking: An Active-Learning Course in Critical Thinking." Current Issues in Education, *2*(5). 30 September, 1999. <http://cie.ed.asu.edu/volume2/number5/>.

Slife, Brent. The Significance of Theoretical Training for Critical Thinking. Chicago: American Psychological Association, 1997.

Chapter 2

Research on Technology and Learning

A number of research studies have examined aspects of educational technology use that were found to result in measurable benefits to learners. Again, Edvation aligns these aspects with both macro- and micro-instructional strategies.

Research Finding

ON TECHNOLOGY AND ACTIVE LEARNING

Technology improves student performance by involving students actively in the learning process.

Research Evidence

Active learning is "anything that involves students in doing things and thinking about the things they are doing" (Bonwell & Eison). "It is a process of discovery in which the student is the main agent, not the teacher" (Adler, 1982 qtd. in Boswell).

"Telecommunications and multimedia workstations bring vast resources of information into the classroom for students to employ in the learning process. The technologies provide students with the opportunity to work actively with the new concepts they are learning and support the assimilation of new information" (Morgan, 1996 qtd. in Hopson).

"Constructivist approaches to learning strive to create environments where learners actively participate in the environment in ways that are intended to help them construct their own knowledge, rather than having the teacher interpret the world and insure that students understand the world as they have told them. In constructivist environments, like Mindtools, learners are actively engaged in interpreting the external world and reflecting on their interpretations. This is not 'active' in the sense that learners actively listen and then mirror the *one* correct view of reality, but rather 'active' in the sense that learners must participate and interact with the surrounding environment in order to create their own view of the subject. Mindtools function as formalisms for guiding learners in the organization and representation of what they know" (Jonassen).

"Because many new technologies are interactive […], it is now easier to create environments in which students can learn by doing, receive feedback, and continually refine their understanding and build new knowledge" (CBASSE, 2002).

From Research to Practice

There are a number of technology integration practices that lead students to active involvement in their own learning. These include the use of:

- **Web tools** that allow students to independently search for, and retrieve, information in multiple formats
- **Digital acquisition devices** (e.g., probeware, cameras) that allow students to gather raw, digital data ready for analysis

- **Communication tools** (e.g., email, networks, and video-conferencing) that allow students to work collaboratively in electronic communities to actively create knowledge and solve problems

- **Productivity tools** (e.g., spreadsheets, databases, and word processors) that allow students to work with information, quickly constructing knowledge through organization, manipulation, representation, and analysis of information / data

- **Authoring / Desktop-Publishing tools** that allow students to independently create professional products including traditional information products, multimedia products, and non-linear interactive products

The instructional design of Edvation content incorporates these tools where they will add value to the learning experience.

Edvation activities pose challenges that are designed to be appealing and potentially rewarding to students so that they may become actively engaged in learning. As they work to fulfill the challenges posed, students use the tools described above to help them to develop their own products and solutions. Students become involved actively in the process of constructing knowledge as they manipulate materials in a quasi-concrete, digital environment.

Having gathered relevant data or information, for example, students use databases and concept maps, to organize and analyze what they know and to assist them in identifying relationships between pieces of information. Students may use spreadsheets to perform calculations, to organize and chart data, to make predictions (using 'what if?' functions), and to run trials. This may be extended into the development of dynamic models and simulations that together with manipulable graphics and animations contribute to students' visualization of concepts. Finally, students use digital tools to assist them in developing professional demonstrations of their understandings in the medium of their time.

In the book *Field Studies: Quadrats*, students undertake scientific field work. They are actively involved in the construction of knowledge as they investigate an ecosystem using the quadrat sampling method to estimate populations of macro invertebrates in a sample area. Students use Excel to calculate the population density of each species, then use the data gathered to answer analytical questions. Through their analysis, students develop their own understandings about the types and numbers of species of macro-invertebrates within a particular ecosystem.

In the book *Online Volunteering*, students learn how to investigate global service opportunities and practice responding to a call for volunteers. If they wish, they may become involved in a specific online project that allows them to join with others worldwide to solve a problem in a developing country. In doing so, they will learn actively about the needs of people in one part of the world, as well as developing general understandings about global citizenship.

In the book *Make a Field Trip*, students are actively involved in designing a virtual field trip for others to enjoy. In developing the product students select appropriate video, audio, and graphics to make the experience come alive for their visitors.

Works Cited

Bonwell, Charles C. and James A. Eison. Active Learning: Creating Excitement in the Classroom, 1991. ERIC Document Reproduction Service ED340272. <http://ericae.net/edo/ED340272.htm>.

Bonwell, Charles C. Active Learning: Creating Excitement in the Classroom, Active Learning Workshops. <http://www.macomb.cc.mi.us/arc/DLmaterials/Bonwell.Active Learning. January 2003.pdf>.

Commission on Behavioral and Social Sciences and Education (CBASSE) How People Learn: Brain, Mind, Experience, and School: Expanded Edition. The National Academies Press, 2000. <http://www.nap.edu/books/0309070368/html>.

Hopson, Michael H., Effects of a Technology Enriched Learning Environment on Student Development of Higher Order Thinking Skills, August, 1998. <http://www.tcet.unt.edu/research/dissert/hopson/index.htm>.

Jonassen, David, Chad Carr, and Hsiu-Ping Yueh. Computers as Mindtools for Engaging Learners in Critical Thinking, University of Missouri. 1998. <http://www.esev.ipv.pt/3siie/actas/actas/doc01.pdf>.

Research Finding

ON TECHNOLOGY AND HIGHER-ORDER THINKING

"Technology can enable the development of critical thinking skills when students use technology presentation and communication tools to present, publish, and share results of projects" (CARET).

Research Evidence

The higher-order thinking skills include:

- **Analyzing -** examining, organizing, outlining, differentiating, selecting, designating, inferring, concluding, diagnosing
- **Synthesizing / Creating** (putting parts together to make a new whole) - planning, combining, compiling, composing, generating, revising, modifying, solving, (answering 'What would happen if?' questions) testing
- **Evaluating** - critiquing, judging, criticizing, comparing, appraising, assessing

Studies cited by CARET:

In a study of seven urban districts that compared the performance of students who used online communication and the Internet and those who did not, researchers found that online use can increase thinking skills. Students who used technology scored higher "on measures of effective presentation, accuracy of information, presentation of full picture, completeness of the assignment, and they scored higher overall" (CAST 1996).

"Hypermedia presentations promote retention and higher-order thinking over time." In a study of ninth graders who developed hypermedia presentations researchers found that "as students perceived the benefits of planning with the hypermedia, students also developed generalizable skills such as taking notes, finding information, coordinating their work with other team members, writing interpretations, and designing presentations" (Lehrer et al., 1994).

"When both words and pictures are presented, learners can engage in selecting images, organizing images, and integrating words and images" (Mayer, 2001, p.189).

Other Studies:

"While hypermedia systems have traditionally been used as information retrieval systems which learners browse, learners may create their own hypermedia knowledge bases that reflect their own understanding of ideas. Students are likely to learn more by constructing instructional materials than by studying them. Designing multimedia presentations is a complex process that engages many skills in learners, and it can be applied to virtually any content domain" (Jonassen).

"Some of the major thinking skills that learners need to use as designers, include project management skills, research skills, organization and representation skills, presentation skills, and reflection skills" (Carver, Lehrer, Connell, & Ericksen 1992).

"There is evidence that the use of ICT impacts more significantly on higher-order thinking than on lower-order cognitive processing and rote learning" (Educational Testing Service, 1989 qtd. in Cuttance).

From Research to Practice

A number of technology integration practices encourage the use of higher-order thinking skills. Significant amongst these is the use of **authoring / publishing tools** in the design and development of complex products such as videos, multimedia presentations, and interactive, non-linear documents. (Non-linear representations reflect thought processes and the interconnectedness of knowledge more closely than flat documentation.) The instructional design of Edvation content incorporates authoring tools where they will add value to the learning experience.

In the development of complex products, students "function as designers, and their computers function as Mindtools for interpreting and organizing their personal knowledge" (Jonassen). The development of a complex product requires that students involve themselves in higher-order thinking as they compose the text of the product, as they make decisions about which materials should be included to support their message, as they plan for the viewer's use of their product, and as they evaluate the effectiveness of their product. Questions are often included in the follow-up to Edvation activities that require higher-order thinking as students reflect on their learning experience.

In the book *World War II Video Essay,* students write an essay about one aspect of the war. They then choose photographs, transitions, and music to develop their presentation into a video essay, As students seek out visual and audio materials to convey their understandings and reactions to what they have learned, they necessarily think deeply about the topic, and engage in problem-solving and decision-making each of which calls for higher-order thinking.

In *Explore the Solar System,* students create a 'Space Explorer console' that demonstrates their understanding of the main celestial features in the solar system. Students imagine that they are traveling through space in the Space Explorer and as they approach each planet, their console - a pre-prepared PowerPoint slide - displays an image of the surface of the planet and information about its temperature, gravity, orbital velocity etc. In creating individual console screens, students learn important facts about each of the planets. This knowledge is then used to answer significant questions about the solar system and to write a mission analysis.

Using word processors, hyper-linking, and in-text comments, students can construct multidimensional products that demonstrate their interpretations of - and reactions to - texts. Without compromising the original document, students can add interpretive comments to a piece of literature (e.g. a hyperlink to a paraphrase of a passage in *Brown v. the Board of Education*), or evaluative / explanatory comments to a piece of their own work. (In the book *Logos Ethos and Pathos in Advertising*, for example, students not only show instances of different types of persuasive appeals on a Venn Diagram, but each instance is hyperlinked to a table in which their response is explained / justified.) The multi-dimensionality of digital documents permits the inclusion of explicit explanation, analysis, evaluation, and meta-thinking within a product.

Works Cited

Carver, S. M., R. Lehrer, T. Connell, and J. Ericksen. "Learning by Hypermedia Design: Issues of Assessment and Implementation." Educational Psychologist, 27 (3) (1992): 385-404.

Center for Applied Research in Educational Technology. Research Guideposts to Better Technology Decisions: Student Learning. International Society for Technology in Education. 2005. <http://caret.iste.org/index.cfm?fuseaction=evidence&answerID=9>.

Center for Applied Special Technology (CAST). The Role of Online Communications in Schools: A National Study. Peabody, MA. 1996. <http://www.tcet.unt.edu/research/rlonline.htm>.

Cuttance, Peter . "Information and Communication Technologies." School Innovation: Pathway to the Knowledge Society. Australian Government, Department of Education, Science and Training. <http://www.dest.gov.au/sectors/school_education/publications_resources/school_innovation/chapter_4.htm>.

Jonassen, David, Chad Carr, and Hsiu-Ping Yueh. Computers as Mindtools for Engaging Learners in Critical Thinking, University of Missouri. 1998. <http://www.esev.ipv.pt/3siie/actas/actas/doc01.pdf>.

Lehrer, R., J. Erickson, & T. Connell. "Learning by Designing Hypermedia Documents." Computers in Schools *10* (1-2) (1994): 227-254.

Stoney, Dr. Sue, and Dr. Ron Oliver, "Can Higher Order Thinking and Cognitive Engagement Be Enhanced with Multimedia?" Interactive Multimedia Electronic Journal of Computer-Enhanced Learning (IMEJ). Wake Forest University. <http://imej.wfu.edu/articles/1999/2/07/index.asp>.

Related Reading

Anglin, G., R. Towers, and H. Levie. "Visual Message Design and Learning: The Role of Static and Dynamic Illustrations." In D.H. Jonassen (Ed.), Handbook of

Research for Educational Communications and Technology. New York: Simon and Schuster Macmillan, 1996.

Jonassen, D. H. (in press). Mindtools for Engaging Critical Thinking in the Classroom, 2nd Ed. Columbus, OH: Prentice-Hall.

Sherry, Lorraine, Shelley Billig, Daniel Jesse, and Deborah Watson-Acosta. Assessing the Impact of Instructional Technology on Student Achievement. <http://www.thejournal.com/magazine/vault/A3297.cfm>.

Research Finding

ON TECHNOLOGY AND PROBLEM SOLVING

"Technology can enable the development of higher order thinking skills when students are taught to apply the process of problem solving and are then allowed opportunities to apply technology in development of solutions" (CARET).

Research Evidence

Studies cited by CARET:

Eighth grade students whose teachers effectively used technology for 'simulations and applications' to enhance higher-order thinking skills performed better on the National Assessment of Education Progress test than did students whose teachers did not use the technology (Wenglinsky 1998).

"Powerful technologies are now available to significantly augment the skills that are necessary to convert data into information and transform information into knowledge" (Moinar 1997).

Other Studies:

"Using a [multimedia] microworld meant that more emphasis was placed on the acquisition of higher-order thinking and problem-solving skills, with less emphasis placed on the assimilation of a large body of isolated facts" (Stoney).

"Mindtools are computer applications that, when used by learners to represent what they know, necessarily engage them in critical thinking about the content they are studying' (Jonassen, 1996).

"Databases, spreadsheets, computer-assisted design, graphics programs, and multimedia authoring programs allow students to independently organize and analyze, interpret, develop, and evaluate their own work. These tools engage students in focused problem solving, allowing them to think through what they want to accomplish, quickly test and retest solution strategies, and immediately display the results" (Peck & Dorricot 13).

"When provided with technology, students are more likely to take comparison of their learning, stay focused until the task is complete, and pursue more obscure and hypothetical solutions to problems" (Hopson).

From Research to Practice

A number of technology integration practices support problem-solving in the classroom. Foremost amongst these is the use of productivity tools, especially databases, and spreadsheets. The processing power provided by these tools frees students from routine tasks (such as calculation and representation) and provides them with the time and the means to thoroughly develop solutions to problems.

A number of features in word processing applications may also be applied in problem-solving situations. Annotation tools for example help students to learn - and specifically to solve problems - through writing.

Productivity tools can help students to:

- Perform complex calculations
- Compare multiple representations of a problem
- Develop graphic representations of data that reveal relationships and expose trends
- Work with large data samples, explore patterns, and make generalizations
- Visually represent concepts (possibly abstract) in an environment that facilitates manipulation and promotes experimentation
- Build interactive models to construct knowledge of dynamic systems
- Simulate real-world phenomena and test conjectures
- Carry out investigations otherwise inaccessible within the classroom
- Efficiently record, sort, filter, and manipulate data in order to solve specific information problems
- Use information generated to infer relationships, draw conclusions, form predictions, and devise new questions
- Focus on analysis, synthesis, and evaluation

The instructional design of Edvation content incorporates productivity tools where they will add value to the learning experience. They are used as a means to manage information and to transform it into usable knowledge - knowledge that will help students to inform decisions and solve problems. As demonstrated in the examples below, the use of productivity tools in a problem-solving context, regularly involves students in higher-order thinking tasks such as hypothesizing, testing, identifying patterns / sequences, comparing / contrasting, analyzing, and evaluating.

In *Gravity Simulation*, students build a simulation that shows a box falling. They then use it to not only investigate gravity but to compare the surface gravity of different planets. Instead of a rote definition of gravity, students' exploration of their models allows them to adjust variables, observe effects, and answer their own questions. In the extension section, students are given ideas for additional features for the basic model to make it more realistic for others to work with.

In *Classification of Rocks*, students work with each other to construct a database on igneous, sedimentary, and metamorphic rocks. Using information from the database they compare, contrast, and identify various rock specimens. Higher-order thinking skills are employed as students manipulate (search and sort) data to address specific questions or to make inferences.

In the book *I Have a Dream*, students use tools of annotation and deconstruction to solve problems of text interpretation. The use of these tools (specifically the Highlight tool, the hyperlink to a bookmark facility, and in-text comments) encourages students to read critically, commenting on what is being said, and how, and why. They encourage students to actively record their thinking as they read.

Works Cited

Center for Applied Research in Educational Technology. Research Guideposts to Better Technology Decisions: Student Learning. International Society for Technology in Education. 2005. <http://caret.iste.org/index.cfm?fuseaction=evidence&answerID=9>.

Hopson, Michael H., Effects of a Technology Enriched Learning Environment on Student Development of Higher Order Thinking Skills, August, 1998. <http://www.tcet.unt.edu/research/dissert/hopson/index.htm>.

Jonassen, D. H., and T. C. Reeves. Learning with technology: Using Computers as Cognitive Tools. In D. H. Jonassen (Ed.), Handbook of Research for Educational Communications and Technology (pp. 693-719). New York: Simon & Schuster Macmillan, 1996.

Molnar, A. S. "Computers in Education: A Brief History." T. H. E. Journal (Technological Horizons In Education), *24*(11), 63-69. 1997. <http://www.thejournal.com/magazine/vault/A1681.cfm>.

Peck, K., and Denise Dorricot. "Why Use Technology?" Educational Leadership. April 1994, p. 11-14.

Wenglinsky, H. Does it compute? The Relationship Between Educational Technology and Student Achievement in Mathematics. Princeton, NJ: Educational Testing Service. 1998. <ftp://ftp.ets.org/pub/res/technolog.pdf>.

Related Reading

Center for Applied Special Technology (CAST). The Role of Online Communications in Schools: A National Study. Peabody, MA. 1996. http://www.tcet.unt.edu/research/rlonline.htm.

Coley, R., J. Cradler, and P. Engel. Computers and Classrooms: The Status of Technology in U.S. Schools. Princeton, NJ: Educational Testing Service, 1997.

Hopson, Michael H., Richard L Simms, Gerald A. Knezek. "Using a Technology-Enriched Environment to Improve Higher-Order Thinking Skills." Journal of Research on Technology in Education. December 22, 2001.

Research Finding

ON TECHNOLOGY AND STUDENT ACHIEVEMENT

"Technology improves student performance when the application directly supports the curriculum objectives being assessed" (CARET).

Research Evidence

Studies cited by CARET:

"Technology can have the greatest impact when integrated into the curriculum to achieve clear, measurable educational objectives" (CEO Forum, 2001).

"Significant student achievement gains for technology integrated with standards were demonstrated by an eight-year longitudinal study of SAT I performance at New Hampshire's Brewster Academy" (Bain & Ross, 1999).

A West Virginia study of the use of technology to develop reading and mathematics skills, reported that "gains in student test scores on the SAT-9 (for 950 fifth graders in 18 schools) were attributable to the alignment of the targeted curriculum objectives with the software, teacher instruction, and the tests" (Mann et al.,1999).

Other Studies:

"Technology offers opportunities for learner-control, increased motivation, connections to the real world, and data-driven assessments tied to content standards that, when implemented systemically, enhance student achievement as measured in a variety of ways" (Gilbert et al).

"The impact of technology is most powerful when focused on specific, measurable educational objectives" (Fahnoe).

Research about scaffolding and student achievement

The findings of the CEO forum of 2000 state that educators must "redouble [their] efforts to integrate digital content into the curriculum in order to ensure [they] apply these powerful tools in the creative ways that enhance student learning."

From Research to Practice

edClass is a standards-based technology integration product. Based on research that suggests that students learn best when technology is designed to achieve specific educational objectives, edClass provides integration activities that teachers can use both in the classroom today, and as models of sound practice when designing their own lessons.

The design process used to develop Edvation activities increases the potential for student achievement. In most cases, it begins with learning objectives drawn from various state standards. The process then identifies ways in which technology might best support this learning so that an experience can be designed that will fulfill the educational objectives.

To contribute to their understanding of "patterns humans make on places and regions," students may use the Edvation book *Town in Time* to create a PowerPoint presentation that shows changes in a town over time. A social, economic or cultural reason is noted (using an in-text comment) for each new town component. When run as a slide show, students watch the development of the town unfold before their eyes.

In the Edvation book *Arithmetic Sequences and Series*, students use a spreadsheet model to explore arithmetic sequences and series. They can adjust the first term and constant difference of a sequence, and see the results in graphical form immediately. Students then complete a number of exercises that lead them toward identifying patterns, and applying formulas to verify points. The result is a visualization of an arithmetical concept that generally *consolidates* students' conceptual understandings related to arithmetic sequences and series.

A number of Edvation activities contribute to student success by providing scaffolds to frame potential learning. In a digital environment, a scaffold may appear within a working document (maximizing the likelihood that a student will be able to fulfill the task requirements), then it may be hidden from view as the student proceeds to publication. The structural overview used in the Edvation book *Write an Argumentative Essay,* for example, prompts a student's thinking as she develops a piece of persuasive writing. Supported by the scaffold, the student can focus on the quality of her arguments and evidence, rather than on remembering the structural details of the genre. In a digital medium a scaffold may be modified over time to move students to increasing levels of understanding.

Works Cited

Center for Applied Research in Educational Technology. Research Guideposts to Better Technology Decisions: Student Learning. International Society for Technology in Education. 2005. <http://caret.iste.org/index.cfm?fuseaction=evidence&answerID=1>.

CEO Forum. School Technology and Readiness. Summer 2000.

http://www.ceoforum.org/downloads/report3.pdf

Fahnoe, Jeff. Using Technology to Encourage Higher Order Thinking Skills. Office of Educational Technology , University of Delaware. <http://www.udel.edu/educ/jfahnoe/presentations/higherorder/index_files/frame.htm>.

Gilbert, Valdez, Mary McNabb, Mary Foertsch, Mary Anderson, Mark Hawkes, and Lenaya Raack. Computer-Based Technology and Learning: Evolving Uses and Expectations. North Central Regional Educational Laboratory. <http:// www,ncrel.org/tplan/cbtl/execsum.htm>

Mann, D., C. Shakeshaft, J. Becker, and R. Kottkamp. West Virginia Story: Achievement Gains from a Statewide Comprehensive Instructional Technology Program. Milken Exchange on Educational Technology. Santa Monica, CA: 1999.

Related Reading

West Virginia Department of Education. West Virginia Technology Program Cited For Increasing Student Achievement. Milken Exchange. Charleston, WV <http://wvde.state.wv.us/news/16/>.

Research Finding

ON TECHNOLOGY AND STUDENT ATTITUDES

"Technology improves motivation, attitude, and interest when students use computer applications that adjust problems and tasks to maximize students' experience of success" (CARET).

Research Evidence

Studies cited by CARET:

"Computer use increases student motivation to learn. In a review of studies pertaining to rudimentary technology applications, Coley et al. found that computer-based instruction can individualize instruction and give instant feedback to students"(1997).

"Increased motivation of students for learning with computers is related to ease of error correction, semi-private environment, increased self-esteem, active control of their immediate environment, and ability to work at their own pace" (Underwood & Brown, 1997).

In 176 studies conducted between 1990 and 1994, "student attitude toward learning and student concept were both found to be consistently increased in a technology rich environment" (Sivin-Kachala & Bialo, 1994).

Other Studies:

"In a national study of technology's role in education reform […] Means and Olson (1995) found impacts related to content, student motivation and self-esteem, use of time, school structure, and changes in teacher roles. These findings also reflect outcomes found in the Apple Classrooms of Tomorrow and other long-term studies" (Expert Panel on Educational Technology).

"A five-year report (1987-1992) by the Sacramento School District in California found that students using multimedia and telecommunications showed improved attitudes toward reading, social studies and science, and became more active and independent in learning" (NSBA).

From Research to Practice

The instructional design of Edvation content incorporates aspects of technology that have been identified as being motivating to students. To truly engage in a task, for example, students need to see it as legitimate or authentic. Technology increases student access to real-world tasks.

The Edvation book *Stock Market* for example, asks students to determine hypothetically whether they should leave their money in a bank savings account or invest it in shares. This is a task that students see as legitimate;

it involves a real world financial decision-making process. Students choose four companies in which to 'invest' and track the value of their shares over an eight-week period using daily stock reports from newspapers or from the Internet. At the end of the period, students create a report to demonstrate the progress of their portfolio. For each stock they must show their initial investment, the final value of their shares and the profit / loss.

The motivation of a real-world context is mirrored by students' interest in the use of real world tools and current data. In the Social Studies book *Nautical Adventure*, therefore, students are asked - in their role as the captain of a cargo ship - to use the Oceanweather Web site to record the latitude and longitude of their ship and to plot its position on a map. Over a period of days they use the current marine data to track the path of their ship. Later - when their navigation system fails - they use a Web-based telescope to navigate by the stars. In the Math book, *Waiting for the Tide*, students use tide data from a NOAA website to develop a sinusoidal model that predicts the height of the tide at any given time. By importing the data using a Refreshable Web Query, you can update the data in Excel as the tide data is posted to the website.

The use of the Internet gives students access to **authentic primary source materials** that allow them to virtually experience aspects of historical - and current - events, remote to them in time or place. Using Web resources, students can view significant documents in their original form, listen to recordings of significant speeches, view historic photographs, watch videos of historical events as they occurred, and even experience history in the making as they watch live footage via Web cams and news sites. Many Edvation activities involve the use of primary source documents so that students may be motivated by their relative closeness to historic materials. In *Documents of Freedom*, for example, students study the Declaration of Independence and the Constitution of the United States in order to identify common themes. These are represented on a Venn Diagram and linked to relevant passages in the documents that exemplify particular themes.

As these examples show, the use of technology within the classroom can make learning more authentic, thereby increasing student motivation. It may also provide increased opportunities for students to:

- Work cooperatively with other students
  A Sticky Investigation
- To have active control over their work (including autonomous research)
  Overview of the Information Process
- To receive feedback (through technologies that support peer or teacher review)
  Metaphors for the Mind
- To use tools for revision
  Create with Information

- To experience success through the creation of professional products that are valued by today's public and / or academic community
  I Know a Place

Works Cited

Archived information: Background Paper for the Expert Panel on Educational Technology. August 31, 1998. <http://www.ed.gov/offices/OERI/ORAD/Background/lessons.html>.

Center for Applied Research in Educational Technology. Research Guideposts to Better Technology Decisions: Student Learning. International Society for Technology in Education. 2005. <http://caret.iste.org/index.cfm?fuseaction=evidence&answerID=10>.

Coley, R., J. Cradler and P. Engel. Computers and Classrooms: The Status of Technology in U.S. Schools. Princeton, NJ: Educational Testing Service, 1997.

NSBA. Technology's Impact on Learning. <http://www.nsba.org/sbot/toolkit/tiol.html>.

Underwood, J., and J. Brown (Eds.) Integrated Learning Systems: Potential into Practice. Oxford, UK: Heinemann / NCET, 1997.

Research Finding

ON TECHNOLOGY INTEGRATION

"Technology improves student performance when the application is integrated into the typical instructional day" (CARET).

Research Evidence

Studies cited by CARET:

"Classroom use of computer applications was demonstrated to be more effective than lab use for teaching mathematics. […] Students working with standards-based software receiving standards-based instruction […] in the classroom, achieved better than students working in computer laboratories" (Mann et al., 1999).

"Computer simulations […] and 'Instructional Learning Systems' […] are effective only when they are integrated into the 'regular classroom instruction' " (Kulik 2003).

Other Studies:

“The true value of technology for learning lies not in learning to use technology, but in using technology to learn” (Educational Research Service, 2001 qtd. in Muir).

"Teachers and administrators are recognizing that computer skills should not be taught in isolation, and that separate 'computer classes' do not really help students learn to apply computer skills in meaningful ways" (Eisenberg).

"Directed computer teaching does not allow children to be creative learners, able to think and make connections for themselves, and so is unlikely to support the development of higher order thinking (e.g. Papert, 1981: Underwood and Underwood, 1990). This criticism assumes constructivism: the claim that knowledge is the product of an active process of construction rather than a passive assimilation of information" (Wegerif).

From Research to Practice

Edvation's edClass activities are technology integration activities, designed to fit into a typical instructional day. They are curriculum-driven rather than technology-driven. While working through an edClass activity, the guidance focuses students on the key curriculum concepts at hand. New technology skills are woven into this meaningful context so that students learn these skills as they are needed. Technology skills are not learned in isolation, but are learned as part of completing real world tasks that often involve a number of different skills.

As part of the Language Arts curriculum, students complete a unit of work on historical fiction and are required to write a piece in this genre. Edvation, therefore provides for teachers, a classroom-ready activity - *Fact and Fiction* - that supports the achievement of this standard. Students are asked to plan and develop a story in PowerPoint that includes both fact and fiction slides. As students work on this task, they learn to design a PowerPoint slide (adding text and graphics), insert a hyperlink from a word in the fictional text to an associated fact slide, insert and format an action button to return to the fiction slide.

So that students can compare the fat content of a variety of fair food items, they learn to sort data in a database from highest to lowest values. They go on to use a formula that multiplies the amount of fat in an item by 9 (each gram of fat has 9 calories) to determine the amount of calories from fat. They fill the formula down the column of the worksheet to determine the calories from fat for each food item. This allows them to see which foods exceed the daily recommended maximum of 585 calories from fat. Students use a division formula to calculate the percentage of calories from fat for each food. They format the cells in the answer column to read as percentage values. In the final steps of the activity students, driven by curriculum goals, students learn to use the chart wizard to create a bar graph that compares the total calories of fair foods with the calories from fat fro each food item. They learn to format the graph and to paste it into a Word document where it may be used as part of an analytical report.

The book *Drifting Continents* was designed to help students develop their understanding of Wegener's Continental Drift theory that proposes that the continents were once compressed into a single landmass that he called Pangaea. Working with a map of Pangaea on a PowerPoint slide, students model the movement of the continents over the different stages of geological time. As part of this process they learn how to rotate a graphic, how to animate text boxes to appear and to disappear (or exit), and how to draw and edit a motion path for an object.

Works Cited

Center for Applied Research in Educational Technology. Research Guideposts to Better Technology Decisions: Student Learning. International Society for Technology in Education. 2005. http://caret.iste.org/index.cfm?fuseaction=evidence&answerID=4

Eisenberg, Michael B., Doug Johnson. "Computer Skills for Information Problem-Solving: Learning and Teaching Technology in Context." 1996 ERIC Reproduction Service. ED392463 .

Kulik, J. Effects of Using Instructional Technology in Elementary and Secondary Schools: What Controlled Evaluation Studies Say. SRI International. Arlington, Virginia. <http://www.sri.com/policy/csted/reports/sandt/it/Kulik_ITinK-12_Main_Report.pdf>.

Mann, D., C. Shakeshaft, J. Becker, and R. Kottkamp. West Virginia Story: Achievement Gains from a Statewide Comprehensive Instructional Technology

Program. Milken Exchange on Educational Technology. Santa Monica, CA: 1998.

Muir, Mike. McMel. Maine Center for Meaningful Engaged Learning. University of Maine at Farmington.
<http://www.mcmel.org>.

Wegerif, Rupert. Literature Review in Thinking Skills, Technology and Learning. School of Education, Open University. NESTA Futurelab, 2002.
<http://www.nestafuturelab.org/research/reviews/ts11.htmREPORT 2>.

Research Finding

ON TECHNOLOGY AND LEARNER PRODUCTIVITY

By offloading routine tasks and memorization, technology partners with the learner to increase productivity.

Research Evidence

"Computer tools, unlike most tools, can function as intellectual partners which share the cognitive burden of carrying out tasks" (Salomon, 1993).

"When students work with computer technologies, instead of being controlled by them, they enhance the capabilities of the computer, and the computer enhances their thinking and learning. The result of an intellectual partnership with the computer is that the whole of learning becomes greater than the sum of its parts" (Jonassen).

"Computers can most effectively support meaningful learning and knowledge construction … as cognitive amplification tools for reflecting on what students have learned and what they know. Rather than using the power of computer technologies to disseminate information, they should be used in all subject domains as tools for engaging learners in reflective, critical thinking about the ideas they are studying" (Jonassen).

"The appropriate role for a computer system is not that of a teacher / expert, but rather, that of a mindextension 'cognitive tool' " (Derry and LaJoie, 1993).

From Research to Practice

Edvation's activities are designed to use the computer to amplify the learner's potential. In activities involving the use of data, for example, students use the computer as a tool to quickly gather, store, and chart data. These are routine tasks well suited to the computer's capabilities and may be performed much faster than was previously possible. Freed from these tasks, students can focus on analysis, interpretation, prediction, and experimentation. By assigning 'unproductive' tasks to the computer, the learner can think more productively. As Jonassen suggests, our aim as instructional designers is to "allocate to the learners the cognitive responsibility for the processing they do best, while requiring the technology to do the processing that it does best." (1998).

Refer to examples from the Edvation library discussed in the section: **ON TECHNOLOGY AND PROBLEM SOLVING.**

Works Cited

Derry, S. J., and S. P. La Joie. "A Middle Camp for (Un)intelligent Instructional Computing: An Introduction." In La Joie S. P. and S. J. Derry (Eds.), Computers as Cognitive Tools (pp. 1-14). Hillsdale, NJ: Lawrence Erlbaum Associates, 1993.

Jonassen, David, Chad Carr, and Hsiu-Ping Yueh. Computers as Mindtools for Engaging Learners in Critical Thinking, University of Missouri. 1998. <http://www.esev.ipv.pt/3siie/actas/actas/doc01.pdf>.

Salomon, G., D. N. Perkins, and T. Globerson. "Partners in Cognition: Extending Human Intelligence with Intelligent Technologies." Educational Researcher, 20(3), 2-9. 1991.

Related Reading

Jonassen, D. H., K. L. Peck, and B. G. Wilson. Learning WITH Technology: A Constructivist Perspective. Columbus, OH: Prentice-Hall, 1998.

Jonassen, D. H., and T. C. Reeves. "Learning with Technology: Using Computers as Cognitive Tools." In D. H. Jonassen (Ed.), Handbook of Research for Educational Communications and Technology (693-719). New York: Macmillan, 1996.

Chapter 3

Principles for Technology Integration

This chapter presents Edvation's own, proprietary 'Principles for Technology Integration.' These are the principles that Edvation uses in its own instructional design processes. These principles succinctly frame aspects of technology that can be used to facilitate desired learning processes in the study of English language arts, mathematics, science, and social studies.

Principles for Technology Integration

EDVATION TECHNOLOGY INTEGRATION PRINCIPLES

FOR

ENGLISH

1. By expediting the routine aspects of text revision, technology facilitates experimentation and ongoing refinement, and frees students to focus on the organization, substance, and efficacy of their writing. Whether deconstructing model text, analyzing ideas, or working through the writing process, in the digital medium students can transform ideas seamlessly, manipulating graphical and textual representations to achieve greater depths of analysis, synthesis, and creativity. (SK.TIP.EN.1)

2. Using professional tools, students control a wide scope of information design decisions and are well positioned to realize their potential to communicate. With open-ended software, students can select, develop, and combine media, messages, and formats to develop satisfying, quality products that address their audience and purpose. (SK.TIP.EN.2)

3. Technology allows students to create multi-dimensional, nonlinear representations of knowledge and interactive information products. Nonlinear representations reflect thought processes and the interconnectedness of knowledge more closely than flat documentation. Using word processors, hyper-linking, and in-text comments, students can construct multidimensional texts. (SK.TIP.EN.3)

4. Global communications increase access to information and to people and their cultures as sources and consumers of information. The Internet extends students' access to relational databases, current data, primary sources, and human expertise and advice. Students may collaborate with others to solve authentic problems, affecting and gaining feedback from a genuine audience. (SK.TIP.EN.4)

5. The digital medium can host dynamic, individualized learning scaffolds - frameworks that build on the learner's existing knowledge, optimizing their attention on the next most constructive concepts. Electronic templates can frame potential learning using devices such as structural overviews, graphic outlines, strategy models and partial solutions to guide student thinking. They can be adjusted over time to move students to increasing levels of understanding. (SK.TIP.EN.5)

Principles for Technology Integration

EDVATION TECHNOLOGY INTEGRATION PRINCIPLES

FOR

MATHEMATICS

1. Using spreadsheets, learners can construct dynamic mathematical models using graphical, numeric, and algebraic representations to make abstract relationships more concrete. Models allow students to explore patterns, make and test conjectures, layer the results of progressive calculations, and compare multiple representations of a problem. (SK.TIP.MA.1)

2. Computer software can free students from repetitive or overly complex calculations so that they can perform a greater number of investigations, in depth, without losing sight of the context of a problem. Processing power also allows students to work with larger data samples to conceptualize statistics principles (such as the experimental / theoretical value relationship). (SK.TIP.MA.2)

3. Using drawing and graphical modeling tools, students can visually represent mathematical ideas in an environment that facilitates manipulation and promotes experimentation. In doing so, students can apply spatial reasoning to aid their learning of geometry and other math topics. (SK.TIP.MA.3)

4. Students can communicate mathematical ideas through multiple modes using multimedia authoring and programming tools. While developing this capacity is a goal in itself, the experience can require that students further analyze and synthesize mathematical concepts. (SK.TIP.MA.4)

5. Integrated application software facilitates students working with data relevant to them and applying mathematical processes in other discipline areas. When using data in a humanities class (e.g. to support statements in a written report), students can process data more thoroughly - analyzing and summarizing – when they can do so digitally. (SK.TIP.MA.5)

EDVATION TECHNOLOGY INTEGRATION PRINCIPLES

FOR

SCIENCE

1. Spreadsheets, used with compatible applications, streamline scientific processes involving data recording, the construction of tables and charts, data analysis, and reporting. Freed from routine tasks, students engaged in scientific inquiry can focus on information analysis, synthesis, and evaluation. (SK.TIP.SC.1)

2. Electronic databases reduce the work of recording, sorting, filtering and manipulating data, allowing students to run many complex queries so they can seek patterns and interpret data. The information generated can be used to compile new data sets, infer relationships, form predictions and devise new questions. (SK.TIP.SC.2)

3. Using computers, students can construct dynamic scientific models and simulate real world phenomena, adjusting variables and observing effects. Models can be used to test conjectures and investigate otherwise inaccessible phenomena. By designing and building interactive models, students can assemble and demonstrate their knowledge of dynamic systems. (SK.TIP.SC.3)

4. Using graphics tools, learners can visually represent scientific ideas in an environment that facilitates manipulation and experimentation. Students can use image directories and animations to visualize concepts and represent their knowledge. Initial representations lead to new questions and revisions. (SK.TIP.SC.4)

5. Information and communication technologies provide access to communities of scientific research and the knowledge they generate. Students can talk with experts and other learners and access archived and current real-world information, virtual field trips, and collaborative projects that pool data. (SK.TIP.SC.5)

6. Digital data acquisition devices including probeware, sensors, cameras and microscopes, expand the range of practical real-world investigations available to students. Enabling students to gather complex sets of raw data in laboratory and remote locations, these devices generate digital information ready for analysis and reporting. (SK.TIP.SC.6)

Principles for Technology Integration

EDVATION TECHNOLOGY INTEGRATION PRINCIPLES

FOR

SOCIAL STUDIES

1. Using information technologies, students can analyze and integrate information to generate personal knowledge. Digitized information can be efficiently retrieved, annotated, arranged, and transformed into representations that expose relationships and trends. Students are freed to focus on research, analysis, synthesis, evaluation, and questioning. (SK.TIP.SS.1)

2. Using graphics tools, learners can visually represent social studies concepts in an environment that facilitates manipulation and experimentation. Students can use image directories and animations to visualize concepts and represent their knowledge. (SK.TIP.SS.2)

3. Technology allows students to create interactive information products that are multidimensional, non-linear representations of their knowledge. Using hyper-linking and in-text comments, students can construct and deconstruct multidimensional texts. Nonlinear representations reflect thought processes and the interconnectedness of knowledge more closely than flat documentation. (SK.TIP.SS.3)

4. Using professional tools, students control information design decisions and are positioned to realize their potential to communicate. With open-ended software, students can select, develop and combine media, messages and formats to contribute effective products to real-world learning communities. (SK.TIP.SS.4)

5. Information and communication technologies provide global access to communities of research and the knowledge they generate. Facilitating autonomous learning, the Internet extends students' access to current data, relational databases, primary sources, remote locations, media-rich learning materials, and human expertise. (SK.TIP.SS.5)

6. The Internet allows students to participate in global learning communities. Through synchronous and asynchronous communications, students may address and influence people separated by geographical boundaries. They may collaborate to build knowledge about real world issues and to apply that knowledge toward solutions. (SK.TIP.SS.6)

9 Lake Bellevue Dr. #105
Bellevue, WA 98005
Tel: 425-454-3373 Fax: 425-467-0580
Email: service@edvation.com