Pan-Canadian Health Informatics Collaboratory

An experimental broadband interactive e-learning environment for Canadian health professionals

Constructivist e-learning methodologies: A module development guide

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This report will:

- Outline best practices for e-learning module development based on the seven principles of constructivism outlined by Maggie Beers at the Waterloo workshop
- Make connections between each of the principles and the activities identified in the "Imagine the possibilities" grid
- Provide information on development of learning outcomes consistent with the principles outlined
- Provide essential "how to" information for developing lesson plans using constructivist learning outcomes and the lesson plan structure outlined in "imagine the possibilities"
- Provide information on the additional steps programs need to take, beyond course design, to implement online learning successfully
- Connect this information to information on the current technological possibilities available to the partners as a group, as of the last survey date

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Best practices in constructivist e-learning

Construction of knowledge

- Learning activities examine the learner's own prior conceptions and relate them to the new knowledge.
- The environment focuses on a problem, project, question, or issue, with various interpretative and intellectual support systems surrounding it.
- Learners have access to resources for problem solving, such as information banks and discussion forums.
- Learners are able to affect the environment in some way by manipulating something, such as constructing a product, manipulating parameters, making decisions.
- Hypermedia and multimedia is used primarily as a medium for the learner to construct knowledge, rather than as a medium to deliver instruction.

Process, not product

- The learning process involves planning the goals, topics and relationship among topics.
- Learners access, transform, and translate information into knowledge through developing new interpretations and perspectives.
- Learners evaluate the quality and quantity of the assembled content.
- It is the process of constructing a perspective or understanding that is essential to learning; no meaningful construction (nor authentic activity) is possible if all relevant information is pre-specified.
- Permit feedback and revision of the knowledge base through reorganization and restructuring of more meaningful content.

Multiple perspectives

- Forums for social negotiation and mediation provide learners opportunities to exchange perspectives and reconcile dissonant views.
- Learners are provided with opportunities for collaboration.
- Learners are able to reconstruct events by configuring a range of perspectives and points of view on a subjective reality.
- Related cases represent the real life complexity of problems.

Situated cognition

- Constructivist learning environments support question/issue-based, case-based, project-based, or problem-based learning.
- Problems are interesting, relevant and engaging.
- All the contextual factors that surround a problem are described.
- The representation of the problem is interesting, appealing, and engaging.
- The problem manipulation space provides a physical simulation of the real-world task.

Reflexive cognition

- Students should be encouraged to become self-regulatory, self-mediated, and self-aware.
- Instructors and learners examine personal beliefs, conceptions, and personal theories about the subject matter, teaching, and learning.
- Learners are asked to articulate their inquiry based problem solving process.
- Learners are encouraged to think-ON action, and think-IN action to develop professionalism.

Cognitive apprenticeship

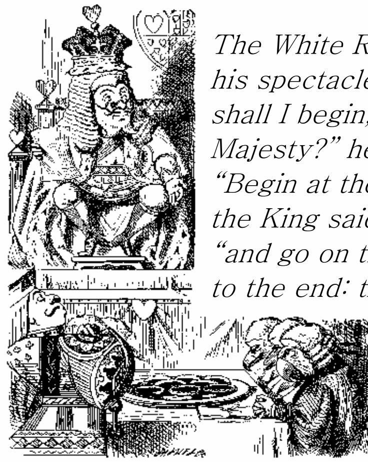
- Students, instructors, and personnel who support the learning receive appropriate training.
- Behavioural modeling of the overt performance and cognitive modeling of the covert cognitive processes assist learners in completing the tasks.
- Coaching allows the learner to improve personal performance to reach a skilled level in task completion.
- Scaffolding provides temporary frameworks to support learning and student performance beyond their capacities.

Process-based evaluation

- Assessment tests the learning outcomes. Assessment of skills involves using the skills, not describing them verbally.
- Self-regulated learners assume responsibility for setting their own goals, determining their own strategies and monitoring their own learning.
- Cognitive tools allow students to move beyond language to represent what they know in ways that are more highly structured and visual.
- Multiple perspectives are included in the evaluation process.

Reader's guide

This document is designed to be consistent with the principles of constructivism as outlined by Maggie Beers at the Waterloo workshop and expanded in this document. Different readers have different learning styles, different motivations for reading the document, and different needs for the information it contains. The document provides multiple possible entry points, a variety of approaches, and different ways to explore best practices in e-learning module development.



The White Rabbit put on his spectacles. "Where shall I begin, please your Majesty?" he asked. "Begin at the beginning," the King said gravely, "and go on till you come to the end: then stop."

You can, if you prefer, follow the advice given to the White Rabbit and read the document front to back. If you'd prefer a different approach, scan the list below and choose your own adventure.

Constructivism review: How do we learn?

A refresher for those who attended the Waterloo workshop, this article presents an historical overview of constructivist theory and introduces seven guideline principles that can be used for e-learning module development.

The principles of constructivism

These documents expand upon each of the seven principles, outlining best practices that flow from each and introducing major theorists in the field.

Developing constructivist outcomes

This overview will assist you in refining your module's learning outcomes.

Putting the pieces together: lesson planning

This presents a nuts and bolts approach to applying the seven principles to the stages of a lesson.

Examples from the field: constructivist learning in action

Two examples are provided – one high tech, one low tech – of complete lessons that exemplify all seven principles.

Constructivist learning activities: Imagine the possibilities!

This grid provides an array of activities for each stage of the lesson, and suggests low, mid and high-tech approaches to each and suggests possible tools for delivery.

Beyond the e-learning module: infrastructure requirements for e-learning

Some partners are here already, and others are on the path. If you're wondering how to put it all together after this project, begin here.

References

This section provides the bibliographic references from the principles, which can also serve as background reading.

Snapshot: HIC partners technological capabilities and experience

Based on the technology survey done in spring of 2002, this snapshot reminds us of where we began.

Technology survey

This is the documentary record of our collective starting point.

Constructivism review: How do we learn?

This article is an adaptation of "Constructivist Approaches to E-learning," a presentation Maggie Beers delivered on behalf of BCIT at a working meeting of the Pan-Canadian Health Informatics Collaboratory: An experimental broadband interactive e-learning environment for Canadian health professionals at the University of Waterloo on April 7, 2002. Given to project collaborators, this presentation was part of an introductory workshop on the fundamentals of constructivist teaching methodologies for e-learning. This article later appeared in the Summer 2002 special issue on constructivism of SideBars, an ezine that supports and recognizes innovative practice in distributed learning: http://online.bcit.ca/sidebars

Have you ever learned a second language? Thumbs up if it was a positive experience, thumbs down if it was a negative one, and sideways if it was a little of both. Now, for those of you who had your thumbs down, why wasn't it so great? For those of you with your thumbs up, what made it so positive?

Since my own teaching and research background is in second language education, I always like to start my discussions on constructivist teaching methodologies with these questions. They always get very heated responses.

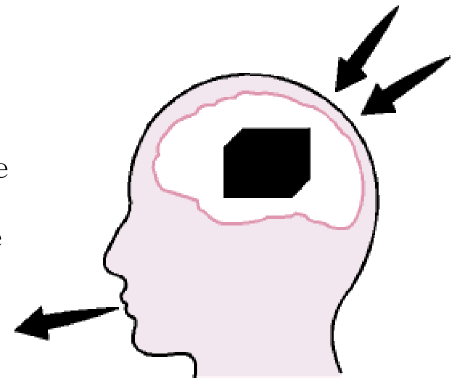
Invariably, the responses, both negative and positive, are all about the instructor. She was awful, she was super! When I ask what the instructor did that made it enjoyable or not, the conversation suddenly turns to teaching philosophy and methodology. Even though these examples are related to language learning, they can be extended across other content areas and domains. After all, subject matter aside, good teaching is good teaching.

If the instructor is remembered with a cringe, it may have been because she made you memorize long lists of grammar rules and vocabulary. She might have humiliated you in front of your peers by making you produce language before you were really ready. Most likely she used English, or the native language where you were living, to talk about the second language rather than actually speaking in the second language.

If you were one of the lucky ones who still hold fond memories of your instructor, it was probably due to the picnics you shared in the outside garden during your unit on food. The real-life soap operas in the second language she let you watch during class didn't hurt either. Or it may have been the safe feeling you had in her classroom that endeared her to you the most. You knew that she would never embarrass you by asking you to perform before you were ready and would provide you with all the support you needed to succeed.

All those enjoyable experiences are linked to constructivist teaching philosophies in one way or another. Constructivism is nothing new. Some say it has been around since Socrates. Elementary schools grabbed onto it a long time ago, but it is only recently making its way into post-secondary institutions where many educators believe that it holds great promise for the online environment. Why has it taken so long and why did you have to suffer through years of shudder-inducing instruction?

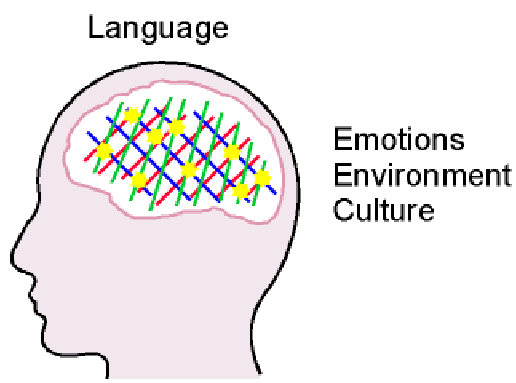
Well, in defence of those instructors you weren't too keen on, they probably had the best of intentions. They were informed by the brain research of the time that said that all language was processed in a "black box" located somewhere in the brain. It was the instructor's duty to help you fill up that box with nouns and verbs so that eventually you could spit it all out in coherent sentences. This was the "fill 'er up" approach to learning that saw the students as empty vessels and the instructor as purveyor of all knowledge.



The Black Box

Things have changed

Now we know that the brain is more like a spider web than a lock 'n key mini storage. All sorts of factors, such as emotions, environment, and cultural assumptions, are the strands that weave this web. Language learning happens where the connections occur, at the intersections of all these strands. The instructor's task is to create these connections for the learner. In this light, it's no wonder that the outside picnic, with all its sounds, smells, tastes, and tactile sensations, not to mention spiders, led to a better language learning experience than the vocabulary lists and pop quizzes. The language learned at the picnic is in there to stay. The other was gone after the quiz.



The Connective Web

It's been a long time coming

Constructivism is such an engaging and collaborative concept that many individuals have contributed to its evolution. What follows will be a quick and dirty overview of a few of the key players. Let's start at the beginning. Socrates.

Socrates [469-399 B.C.]

<http://www.philosophypages.com/ph/socr.htm>
Now here's someone who knew how to ask the right questions. In what

has come to be known as his Socratic Method, he led his students to think critically about a concept through a series of questions. Since he usually didn't present new facts, he figured the students knew the conclusions all along. This lack of absolute answers left his students feeling uneasy, however, and eventually led to his being sentenced to death! Surely you won't share his same fate.

Jean Piaget [1896-1980]

<http://www.time.com/time/time100/scientist/profile/piaget.html>
At the beginning of the 20th century, the Swiss psychologist Piaget found the real way to balance work and family. He spent hours and hours observing his young children in play and, in the process, developed a series of theories to explain how children learn. He decided humans learn through the construction of one logical structure after another. In one of his most well-known theories, Equilibration, he reasoned that the learner constructs these structures by passing through stages of equilibrium and disequilibrium.

In a nut shell, the learner starts out in equilibrium, content with his own vision and order of the world. Through interactions with peers and/or objects, the learner is forced to deal with new perspectives and becomes decentred. Now that the learner's equilibrium is rocked, a new level of equilibrium can be reached only if the learner either assimilates this new concept by fitting it into an existing mental model, or accommodates this new concept by restructuring an existing mental model. Of course, if it's too much of a stretch, this new concept might also get rejected with a big "Does not compute!"

Lev Vygotsky [1896-1934]

<http://www.kolar.org/vygotsky>
At about the same time as Piaget, Vygotsky, a Russian scientist, was coming to some of the same conclusions. Vygotsky gave particular importance to the role of community in social development so, for him, language, culture and significant adults were all integral to the learning process. An important contribution to constructivism was his concept of the Zone of Proximal Development. According to Vygotsky, learners have an actual development level, within which they can solve problems on their own, and a potential development level, within which they can solve problems with adult guidance or collaboration with more capable peers.

John Dewey [1859-1952]

<http://www.infed.org/thinkers/et-dewey.htm>
Europe wasn't having all the fun, though. In the United States, Dewey was busy revolutionizing the ways we thought about education and learning. Some of his philosophies, especially his concern with interaction, reflection and experience, and interest in community and democracy served to inform many educational trends, as well as the approach we now know as constructivism. Dewey lived in the heart of America and had a deep connection to the land. He believed in the power of learning-by-

doing, now referred to as problem-based learning, rather than rote memorization and dogmatic instruction.

Jerome S. Bruner [1915-]

<http://www.infed.org/thinkers/bruner.htm>
If you really want your students to learn, according to Bruner, let them sink their teeth into something really difficult and let them discover new ideas on their own. He thinks of education as a process of discovery. Sure, you can help them along by setting up great learning experiences and asking the right questions, but ultimately it's the students who know best where to catalogue this information in their heads. Only they know where their brains are at. As they get new information, they can classify it based on the knowledge that's already there. Of course, the goal isn't to create what Bruner calls "little living libraries on that subject" but to get the students actively involved in the whole process. If they're learning history, get them thinking like the historian might think. In an educational version of poker, process beats product, hands down.

Seymour Papert [1928-]

<http://www.papert.com/>
So how do all of these ideas translate into the distributed learning environment? In comes Papert, a former student of Piaget, and founder of MIT's media lab. Papert has spent most of his professional life advancing the ideas of Piaget by developing his own theories of constructionist teaching practices.

Constructionism is a teaching method that assumes individuals, especially children, are more actively engaged when working on a personally meaningful external artifact, whether it be a sand castle or a theory of the universe, which they can share with others. He calls these artifacts "objects-to-think-with." Papert remembers his bicycle gears as his first object-to-think-with. The joy he derived from thinking about them, tinkering with them, and using them ultimately fuelled his passion for mathematics.

Papert created the computer language LOGO to encourage children to invent their own objects-to-think-with. One such object is Turtle, a computer controlled cybernetic animal which exists within the cognitive minicultures of the LOGO environment. Papert's ideas have inspired some very exciting work in new media, notably from two of his former students: Ricki Goldman-Segall, professor at the New Jersey Institute of Technology and founder of the Multimedia Ethnographic Research Lab (MERLin) <http://www.merlin.ubc.ca> at the University of British

Columbia, and Idit Harel, CEO and Founder of MamaMedia, Inc. <http://www.mamamedia.com> Check out their work, it's a lot of fun.

Now that it's here, what does it look like?

What has emerged from these thinkers mentioned here and many others along the way are lots of different types, or interpretations, of constructivism, which can be lined up on a sort of continuum. On one end is radical constructivism and on the other is cognitive constructivism. In the middle are trivial constructivism, social constructivism, cultural constructivism, and critical constructivism. Not to mention construCTIONism! But let's not go there. If you really want to dive into all that, visit Martin Dougiamas's site <http://dougiamas.com/writing/constructivism.html> and he will set you straight.

For the rest of us, here are seven constructivist guiding principles that the Pan-Canadian Health Informatics Collaboratory can use to develop its e-learning modules. See if you can recognize the ideas of any of the folks above:

1. Construction of knowledge

Instruction focuses on developing the skills of the learner to construct (and reconstruct) plans in response to situational demands and opportunities. It does not attempt to transmit pre-fabricated plans to the learner. Instruction should provide contexts and assistance, in the form of opportunities for mentoring, peer collaboration or personal reflection, which will aid the individual in making sense of the environment as it is encountered.

2. Process, not product

The main goal of constructivism is to move the learner into thinking in the knowledge domain as an expert user of that domain might think. For example, a constructivist history instructor wants her students to learn to think like historians, not to learn a certain version of history. To do this, designers must identify the variety of expert users and the tasks they do. The goal is to portray tasks, not to define the structure of learning required to achieve that task.

3. Multiple perspectives

Students need to learn to construct multiple perspectives on an issue and then evaluate those perspectives, identifying the shortcomings as well as the strengths. Then they adopt the perspective that is most useful, meaningful, or relevant to them in the particular context. Two central strategies for achieving these perspectives are to create a collaborative learning environment and to provide examples.

4. Situated cognition

Meaning is seen as rooted in, and indexed by, experience. The experience in which an idea is embedded is critical to the individual's understanding of and ability to use that idea. Hence, constructivists emphasize "situating" cognitive experiences in authentic, real life activities.

5. Reflexive cognition

The learner focus is on developing skills of reflexivity, not on remembering. In other words, it is on thinking about their thinking. It is about using domain, content knowledge to problem-solve real world problems. Constructivist learning and teaching activities are often designed around an "anchor" which may be some sort of case-study, problem situation, or artifact they are reflecting on while constructing.

6. Cognitive apprenticeship

The constructivist teacher models the process and coaches the students toward expert performance. Scaffolding, in the form of graphic organizers or other support materials, enables the learner to eventually perform the authentic tasks of experts.

7. Process-based evaluation

In a constructivist learning environment, evaluation examines the thinking process. Therefore, it centres on two important elements, "instrumentality" and "metacognitive skills." Instrumentality implies that the perspective that each student develops in the content area is effective in working in that area. Metacognitive skills, or reflexive awareness of one's thinking, imply that the student can think about his/her thinking and defend his/her judgements. One possible type of evaluation would ask learners to address a problem in the field of content and then defend their decisions. Another might ask the learners to reflect on their own learning and document the process through which they have constructed their view of the content.

Each of these principles is developed in more detail in the following section.

The principles of constructivism

Construction of knowledge

> Instruction focuses on developing the skills of the learner to construct (and reconstruct) plans in response to situational demands and opportunities. It does not attempt to transmit pre-fabricated plans to the learner. Instruction should provide contexts and assistance, in the form of opportunities for mentoring, peer collaboration or personal reflection that will aid the individual in making sense of the environment as it is encountered.

Constructivism is an educational philosophy that encompasses a wide variety of views, theories, and instructional models. It believes that learning is an active process of constructing, rather than acquiring, knowledge, and that instruction is a process of supporting that construction, rather than communicating knowledge (Duffy & Cunningham, 1996).

To this aim, the following design considerations for constructivist learning environments can support active *knowledge construction* in its users.

Learning activities examine the learner's own prior conceptions and relate them to the new knowledge.

Piaget (1972) stated that learners don't passively take in knowledge, but actively construct it, one logical structure after another, based on their own prior knowledge and experiences.

Learners integrate new ideas with prior knowledge in order to make sense or make meaning or reconcile a discrepancy, curiosity, or puzzlement. They construct their own meaning from different phenomena. The models they build to explain things are simple and unsophisticated at first, but with experience, support, and reflection, they become increasingly complex (Jonassen, CLEs, n.d.).

To understand why learners behave the way they do, it can be helpful to get an insight into their existing mental structure, or the way they perceive the content before instruction begins. Future understandings of concepts build upon that prior understanding. In a synchronous environment, a student's prior knowledge may be probed at the beginning of instruction and instruction may be adjusted based on the feedback of the student. In an asynchronous environment, the student may be profiled based on the results of a pre-assessment and content released accordingly.

Often times, the best knowledge construction comes from the learners being asked to explicitly reflect on how their understandings of the information have changed after being exposed to new ideas. Learning activities that provide the learner with opportunities to test and try out their new conceptual understandings in various applied circumstances like problem solving enable the learner to bridge between prior and new understandings of the content.

The environment focuses on a problem, project, question, or issue, with various interpretative and intellectual support systems surrounding it.

The goal of the learner is to interpret and solve the problem, complete the project, answer the question, or resolve the issue.

Knowledge construction starts with the learner articulating an intention to build knowledge. That may be stimulated by a question or problem, a failure to achieve something, a general curiosity, an argument or anything that perturbs a person's understanding enough to want to make sense out of it (Jonassen, 2000, p. 173). Once they have decided they want to know, learners then collect and interpret information that relates to their intention.

Learners have access to resources for problem solving, such as information banks and discussion forums.

Constructivist learning environments assume that information makes sense only in the context of a problem or application. Therefore, these environments provide learner-selectable just-in-time resources and links to other relevant information banks and repositories that can support the learners in constructing knowledge around their aim (Jonassen, 1999).

Furthermore, collaborative activities and discussion with other learners provides a rich forum for knowledge construction through problem solving. The multiple perspectives individuals can provide through synchronous and asynchronous discussions are particularly valuable when seeking solutions. Access to shared information and shared knowledge building tools help learners collaboratively construct socially shared knowledge. These collaborative environments enable learners to identify and reconcile dissonant or consonant perspectives in order to solve a problem.

Learners are able to affect the environment in some way by manipulating something, such as constructing a product, manipulating parameters, making decisions.

A constructivist learning environment may suggest a preferred path, but learners are ultimately free to control the sequencing of learning activities. This way, learners are able to follow-through on their own initiative and curiosity in learning.

Learners are able to affect the environment in some way, by manipulating parameters, constructing a product, or making decisions. When the learners know that they can affect the problem situation in some meaningful way, they can assume ownership of the problem.

Problem manipulation spaces are realistic and enable students to test the effects of their manipulations. Learners receive feedback through changes in the physical appearance of the physical objects they are manipulating or in the representations of their actions, such as charts, graphs, and numerical output (Jonassen, 1999).

In creating problem manipulation spaces, it is not always necessary for learners to manipulate physical objects or simulations. It may be sufficient merely to generate a hypothesis or intention to act and then to argue for it (Jonassen, 1997).

Hypermedia and multimedia is used primarily as a medium for the learner to construct knowledge, rather than as a medium to deliver instruction.

In constructionist teaching approaches, which expand on constructivist principles, learners construct external, personally meaningful artifacts that they can reflect on and share with others in a public forum. "It attaches special importance to the role of constructions in the world as a support for those in the head, thereby becoming less of a purely mentalist doctrine" (Papert, 1993, p. 143).

Constructivist learning environments provide learners with the tools to design their own representations of knowledge, in the form of reports, films, concept maps, and other media presentations. Researching the information, organizing and designing the presentation and managing the construction project require critical, creative as well as complex thinking skills. Multimedia tools place students in the designer's seat so that they can construct their own understandings, rather than interpret the teacher's understanding of the world.

Process, not product

The main goal of constructivism is to move the learner into thinking in the knowledge domain as an expert user of that domain might think. For example, a constructivist history instructor wants her students to learn to think like historians, not to learn a certain version of history. To do this, designers must identify the variety of expert users and the tasks they do. The goal is to portray tasks, not to define the structure of learning required to achieve that task.

The learning process involves planning the goals, topics and relationship among topics.

Online education is capable of making vast amounts of very diverse information, knowledge, and skills available to the learner. Databases, document resource centres, and learning object repositories can be made available to the students for their perusal. To ensure the relevance of these materials to the student's learning experience, however, learners are provided the opportunity to self-select a relevant topic, process, or skill to research.

Learners are more motivated if allowed to plan the goals and topics to explore. Formative evaluation provides opportunities to ensure the learner is meeting the pre-established goals, and provides the learner with feelings of success throughout the learning process. As the topics are researched, the learner constructs personally meaningful relationships between the topics, furthering the positive sense of ownership felt over the learning process. Certainly, developers may constrain the learners' choices, by providing them with choices and a preferred path.

Learners access, transform, and translate information into knowledge through developing new interpretations and perspectives.

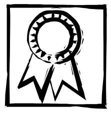
Constructivist learning environments emphasize that learners need to learn to construct multiple perspectives on an issue. This is a dynamic process, since perspectives will constantly change as new information becomes available and the views of other perspectives are articulated. Goldman-Segall (1998) calls this fluid changing of perspective as new perspectives become known "points of viewing." It is valuable for the learner to see that perspectives or viewpoints are not fixed, but fluid, depending on the context and information available.

As learners make the best case possible from each perspective, they explore the domain knowledge from new vantage points. In the process, they forge a variety of personally meaningful paths into the knowledge that they can later access to transfer to new cases.

Learners evaluate the quality and quantity of the assembled content.

In the process of researching the various self-selected topics and skills, learners collect, record and analyze data. At this point, they critically examine their data and determine if the quality and quantity is sufficient to make a reasonable hypothesis. If the learner determines it to be insufficient, they are able to reflect on their research method and data resources and revise their approach, thereby improving their investigative techniques. Once they are satisfied with their data collection, the learners formulate and test a hypothesis.

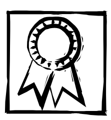
This process of critically reflecting upon their practice, and subsequently testing their decisions, contributes to their intellectual and professional growth by providing the learners with more refined research skills. Ultimately, it is the investigative skills learned in the process that will serve the learner in future professional dealings, the results may be forgotten. It is the process that is important, not the product.



It is the process of constructing a perspective or understanding that is essential to learning; no meaningful construction (nor authentic activity) is possible if all relevant information is pre-specified.

Although a core knowledge domain may be specified, the student is encouraged to pursue alternative points of view in related and relevant knowledge domains. It is true that many knowledge domains cannot be easily separated from each other, since information from many sources can contribute to finding a solution to a problem. Just as learners are encouraged to bring a fresh perspective to classroom discussions, they are also encouraged to seek out new perspectives that can contribute to their understanding and analysis of the issue.

Facts in isolation do not aid the learner in becoming an expert in the chosen domain field. It is more relevant to the developer to identify tasks that the expert performs and then aid the learner in completing these tasks. At first these tasks may need to be simplified, but the content provided to the student should not be reduced to sequential steps to complete the task. That will only promote mechanization of the task and will not enable the learner to transfer this knowledge to new situations or cases. The learner needs to be able to call upon existing resources to research the most appropriate approach to completing the task, develop a hypothesis, and then attempt to complete the task. The experiences the learner accumulates during this process will serve to inform future problem solving cases.



Permit feedback and revision of the knowledge base through reorganization and restructuring of more meaningful content.

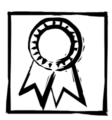
Once a knowledge representation has been created, it can always be repurposed, reused, or improved. This does not necessarily mean that the original representation was inadequate, it merely shows that learning is a life-long process and that this representation serves as a snapshot of where the learner was at that particular point in the process. Feedback from other novices and experts can provide new perspectives and suggestions for change. Similarly, the creator may later revisit a previous knowledge representation with a changed perspective, or new knowledge, and wish to update the content. All creations, stored in databases and learning object repositories, can serve as models and examples to inform future ones and there is a benefit to making them available to all learners.

Multiple perspectives

> Students need to learn to construct multiple perspectives on an issue and then evaluate those perspectives, identifying the shortcomings as well as the strengths. Then they adopt the perspective that is most useful, meaningful, or relevant to them in the particular context. Two central strategies for achieving these perspectives are to create a collaborative learning environment and to provide examples.

Experiencing multiple perspectives of a particular event provides the student with the raw materials necessary to develop multiple representations. These multiple representations provide students with various routes from which to retrieve knowledge and the ability to develop more complex schemas relevant to the experience. In addition, certain interpretations of constructivism assert there is no privileged "truth," only perceptual understandings that may prove to be more or less viable. This being the case, a student's understanding and adaptability is increased when he or she is able to examine an experience from multiple perspectives. These perspectives provide the student with a greater opportunity to develop a more viable model of their experiences and social interactions (Doolittle, 1999).

To this aim, the following design considerations for constructivist learning environments can support the inclusion of *multiple perspectives.*



Forums for social negotiation and mediation provide learners opportunities to exchange perspectives and reconcile dissonant views.

Social interaction provides for the development of socially relevant skills and knowledge, as well as providing a mechanism for perturbations that may require individual adaptation. As an individual gains experience in a social situation, this experience may verify an individual's knowledge structure or it may contradict those structures. If there is contradiction or confusion, the individual must accommodate this contradiction in order to maintain either an accurate model of reality or a coherent personal or social model of reality (Doolittle, 1999). It is in this accommodation stage that learning occurs. Both asynchronous and synchronous online communications allow for social negotiation and mediation to occur across time and distance.

As groups of thinking individuals provide different perspectives and interpretations, debate, argue and compromise on the meanings of ideas and concepts, they are indeed deeply engaged in knowledge construction (Jonassen, 2000).

Learners are provided with opportunities for collaboration.

Students learn about learning not only from themselves, but also from their peers. When students review and reflect on their learning processes together, they can pick up strategies and methods from one another (Grennon Brooks, n.d.)

Collaboration with fellow students can have several benefits to learning. Students can encounter different points of view which may identify ineffective solutions to problems, clarify misconceptions, and give rise to synergistic insights. Group members must understand their different roles and learn to accommodate conflicting ideas (Chan, 2002).

Learners are able to reconstruct events by configuring a range of perspectives and points of view on a subjective reality.

Constructivist approaches to learning encourage individuals to construct their own representations of reality in a variety of media presentations. To do this, individuals are called upon to research the various points of view embodied in source documents, observations and a range of personal accounts of the event. Sociocultural events, in all their complexity, pose particular challenges to the researcher, since accounts can vary greatly based on the subject position of the participant. In her educational theory, configurational validity, Goldman-Segall (1995) suggests that a more robust interpretation of a phenomenon can be achieved when the participants are given a forum in which to view and discuss each other's representations and interpretations of the event.

To provide this forum, she has created a series of multimedia ethnographic research tools, most recently Orion™. Based on the metaphor of stars and constellations, users enter pieces of digital data, or stars, such as a videoclip, sound file or webpage, into a shared database and then group these pieces of data into meaningful knowledge configurations, or constellations. The users are able to annotate their own stars and constellations, as well as those of the others, all the while contributing new perspectives on shared data. As the data base grows, the users create a more robust and multilayered understanding of the event.

Related cases represent the real life complexity of problems.

Problems that reflect real life complexity are made up of multiple perspectives and multiple components and can not be solved in predictable ways. Furthermore, the knowledge presented in these problems is often ill-structured, in that it can not be neatly classified by criteria, attribute or categories. In the course of reflecting on these complex problems, students learn there are many ways of viewing the world and a range of solutions to most of life's problems.

An effective approach to solving these complex problems in a multimedia environment can be found in Spiro's cognitive flexibility theory. Spiro & Jehng (1990, p. 165) state: "By cognitive flexibility, we mean the ability to spontaneously restructure one's knowledge, in many ways, in adaptive response to radically changing situational demands." To facilitate this ability, Spiro recommends the knowledge be represented along multiple rather than single conceptual dimensions, and that learners be asked to actively assemble knowledge, rather than passively retrieve it.

Jonassen et al. (1993, p. 238) provide a useful example of a case-based hypertext on transfusion medicine that applies cognitive flexibility theory to represent multiple realities. The program is oriented by seven primary cases. The student must determine the information needed to take any action (such as ordering tests, diagnosing the problem, or ordering treatment.) The learner has the option of accessing information from a transfusion medicine textbook (a very common source of information in case resolution which represents a well-structured perspective of the knowledge domain), ask questions of important operatives in the case such as the attending physician, pathologist, resident, patient, phlebotomist or blood bank director (which provides conflicting perspectives), or compare the current case to a database of similar cases (accessed bytype of similarity, e.g. symptomology, etiology, pathophysioogy, or treatment). Each of these information sources provides a separate point of view that represents the case in a different way. These are the multiple perspectives that are normally available to a resident in solving a case. When the student takes an action, feedback is presented about the advisability of each action taken based upon these previous perspectives. The transfusion hypertext avoids oversimplifying instruction, provides multiple representations of the transfusion content, emphasizes case-based instruction and context dependent knowledge, supports complexity, and requires knowledge construction rather than transmission.

Situated cognition

Meaning is seen as rooted in, and indexed by, experience. The experience in which an idea is embedded is critical to the individual's understanding of and ability to use that idea. Hence, constructivists emphasize "situating" cognitive experiences in authentic, real life activities.

Constructivist learning environments that encourage situated cognition are based on the belief that learning should be realistic and faithful to the original phenomena, rather than abstract descriptions or "inert knowledge." Instruction should be anchored in real-world problems, events or issues which are appealing and meaningful to students. Realistic problems allow students to take ownership of their solutions, develop deeper, richer knowledge structures, require more systematic problem solving methods, and are more likely to benefit from collaborative efforts (Chan, 2002).

To this aim, the following design considerations for constructivist learning environments can promote *situated cognition.*

Constructivist learning environments support question/issue-based, case-based, project-based, or problem-based learning.

Excerpted from Jonassen, 1999:

Question- or issue-based learning begins with a question with uncertain or controversial elements.

In case-based learning, students acquire knowledge and requisite thinking skills by studying cases (e.g. legal, medical, social work) and preparing case summaries or diagnoses. Case learning is anchored in authentic contexts; learners must think manage complexity and think like practitioners (Williams, 1992).

Project-based learning focuses on a relatively long-term, integrated units of instruction where learners focus on complex projects consisting of multiple cases. They debate ideas, plan and conduct experiments, and communicate their findings (Krajcik, Blumenfeld, Marx, & Soloway, 1994).

Problem-based learning (Barrows & Tamblyn, 1980) integrates courses at a curricular level, requiring learners to self-direct their learning while solving numerous cases across a curriculum.

Case-, project-, and problem-based learning represent a continuum of complexity, but all share the same assumptions about active, constructive, and authentic learning.

Problems are interesting, relevant and engaging.

Excerpted from Jonassen, 1999:

The problem is not overly prescribed. Rather, it is ill-defined or ill-structured, so that some aspects of the problem are emergent and definable by the learners. Ill-structured problem have unstated goals and constraints and have multiple solutions, solution paths, or no solutions at all. It is important to decide if the students possess prerequisite knowledge or capabilities for working on the problem that you identify. Problems in constructivist learning environments need to include three integrated components: the problem context, the problem representation or simulation, and the problem manipulation space. Each one, discussed in detail below, is represented in a constructivist learning environment.

All the contextual factors that surround a problem are described.

Excerpted from Jonassen, 1999:

The same problem in different social or work contexts is different. Constructivist learning environments describe all of the contextual factors that surround a problem in the problem statement. The physical, sociocultural, and organizational climate surrounding the problem is described. Where and in what time frame does it occur? What physical resources surround the problem? What is the nature of the business, agency, or institution in which the problem occurs? What do they produce? If they appropriately describe the situation, annual reports, mission statements, balance sheets, profit and loss statements are provided. What is the history of the setting? This information is made available to learners in order to understand the problem.

What are the values, beliefs, sociocultural expectations, and customs of the people involved? Who sets policy? What sense of social or political efficacy do the members of the setting or organization feel? What are the skills and performance backgrounds of performers? This information can be conveyed in stories or interviews with key personnel in the form of audio or video clips. It is the community of participants who are define what learning occurs in a context.

The representation of the problem is interesting, appealing, and engaging.

Excerpted from Jonassen, 1999:

The representation of the problem must be interesting, appealing, and engaging. It must perturb the learner. Use high-quality video scenarios or virtual worlds for introducing the problem and engaging learners. An effective, low-tech method for representing problems is narrative. The problem context and problem representation become a story about a set of events which leads up to the problem that needs to be resolved. An effective example of narrative forms of problem representations can be found in the Instructional Design Case Studies (Lindeman, Kent, Kinzie, Larsen, Ashmore, & Becker, 1996) http://curry.edschool.virginia.edu/go/ITcases. In these cases, characters are developed who interact in realistic ways to introduce the case problem.

Stories are also the primary means of problem representation and coaching in goal-based scenarios (Schank et al, 1994). The problem presentation simulates the problem in a natural context. Stories are a natural means for conveying them. The problem and its context and representation should be authentic. Some designers insist that authentic refers to supporting the performance of specific realworld tasks. Most believe that authentic means that learners should engage in activities which present the same "type" of cognitive challenges as those in the real world (Honebein, et.al. 1993; Savery & Duffy, 1996), that is, tasks which replicate the particular activity structures of a context.

The problem manipulation space provides a physical simulation of the real-world task.

Excerpted from Jonassen, 1999:

In order for learners to engage in meaningful learning, they must manipulate something- construct a product, manipulate parameters, make decisions - affect the environment in some way… The problem manipulation space provides the objects, the signs, and tools required for the learner to manipulate the environment. Why? Students cannot assume any ownership of the problem unless they know that they can affect the problem situation in some meaningful way. The form of the problem manipulation space will depend on the nature of the activity structures the constructivist learning environment is engaging, however, it should provide a physical simulation of the real-world task. Learners are directly engaged by the world they explore, because they can experiment and immediately see the results of their experiment.

Problem manipulation spaces are causal models that enable students to test the effects of their manipulations, receiving feedback through changes in the physical appearance of the physical objects they are manipulating or in the representations of their actions, such as charts, graphs, and numerical output. They should allow learners to manipulate objects or activities, be sensitive to environment changes in realistic ways to learner manipulations, be realistic, and provide relevant feedback.

In creating problem manipulation spaces, it is not always necessary for learners to manipulate physical objects or simulations. It may be sufficient merely to generate a hypothesis or intention to act and then to argue for it. When engaging learners in solving ill-structured problems, requiring learners to articulate their solutions to problems and then develop a coherent argument to support that solution is sufficient.

Reflexive cognition

The learner focus is on developing skills of reflexivity, not on remembering. In other words, it is on thinking about their thinking. It is about using domain, content knowledge to problem-solve real world problems. Constructivist learning and teaching activities are often designed around a "anchor" which may be some sort of case-study, problem situation, or artifact they are reflecting on while constructing.

In a constructivist environment students are expected to be active in their construction of knowledge and meaning. This activity involves mental manipulation and self-organization of experience, and requires that students regulate their own cognitive functions, mediate new meanings from existing knowledge, and form an awareness of current knowledge structures (Doolittle, 1999).

To this aim, the following design considerations for constructivist learning environments can support *reflexive cognition* in its users.

Students should be encouraged to become self-regulatory, self-mediated, and self-aware.

In a constructivist learning environment, self-regulation, self-mediation, and self-awareness fall under the construct of metacognition. Metacognition is considered to be a fundamental aspect of learning and consists of (1) knowledge of cognition (i.e., knowing what one knows, knowing what one is capable of doing, and knowing what to do and when to do it) and (2) regulation of cognition (i.e., the on-going task of planning, monitoring, and evaluating one's own learning and cognition) (Brown & Palinscar, 1987).

In most online environments, self-regulation, self-mediation and self-awareness are requirements for successfully engaging in that environment. However, few online environments ensure that the students are indeed equipped with these skills to succeed. Students often begin an online educational experience with little preparation in how the online experience differs from the classroom environment (Doolittle, 1999). Online environments that explicitly address these issues and provide learning activities that prepare the student for this environment improve the student's chances for success.

Instructors and learners examine personal beliefs, conceptions, and personal theories about the subject matter, teaching, and learning.

Students and instructors enter the educational experience with firmly held beliefs as to what constitutes good teaching practice and learning (Weber & Mitchell, 1996). While these schemas form the necessary basis from which to assimilate and accommodate new ideas, they can also inhibit learning when the ideas presented do not correspond to previously held notions (Piaget, 1975). In these instances, these beliefs are so deeply rooted that they are difficult to recognize, much less change.

To facilitate this process of altering prior assumptions and attitudes in order to accommodate substantially new concepts, students can benefit from opportunities to systematically reflect on their practice and the assumptions that guide their actions. Likewise, designers and instructors of constructivist learning environments may benefit from reflecting on the beliefs and assumptions that inform the content that they choose and the learning activities they design for the students. If the goal is to allow the learners to construct their own knowledge, it is important that the biases of the educators not cloud their abilities to do so.

Online learning environments have the ability to make the abstract process of reflection apparent for learners and instructors by providing concrete representations, in the form of external artifacts (i.e. written discussions, annotations, knowledge representations such as concept maps and reports), of the relations the learners make between their lived experiences and the new curricular content. Learners and instructors can revisit their interactions and representations in a new light to examine them for biases and changes in perspective.

Learners are asked to articulate their inquiry based problem solving process.

The main activity in a constructivist classroom is solving problems. Students use inquiry methods to ask questions, investigate a topic, and use a variety of resources to find solutions and answers. As students explore the topic, they draw conclusions, and, as exploration continues, they revisit those conclusions. This exploration of questions leads to more questions (Brooks, 2002).

Learners should be required by technology-based learning to articulate what they are doing, the decisions they make, the strategies they use, and the answers that they found. When they articulate what they have learned and reflect on the processes and decisions that were entailed by the process, they understand more and are better able to use the knowledge that they have constructed in new situations (Jonassen, CLEs).

Learners are encouraged to think-ON action, and think-IN action to develop professionalism.

Schön (1983) distinguishes between two different styles of professional thinking—thinking IN action and thinking ON action. "In his day to day practice (the professional) makes innumerable judgements of quality for which he cannot state adequate criteria, and he displays skills for which he cannot state rules and procedures. Even when he makes conscious use of research-based theories and techniques, he is dependent on tacit recognitions, judgements, and skillful performances" (Schön, 1983, p. 50, as cited in Jonassen, Mayes & McAleese, 1999, p. 235).

Reflecting ON action is a process of turning back on one's actions to examine one's feelings and the decision making process to learn from the experience and develop strategies for approaching a similar case in the future. Reflecting IN action is a less formal action that emphasizes thinking on one's feet. It is the process of examining the variables in the present case and drawing from a large knowledge domain of prior experience and content knowledge to make informed decisions. Constructivist learning environments aim to prepare learners to think like experts, which means possessing the skills to effectively think in and on action. These are skills that need to be explicitly taught through learning activities that call on the learners to practice these activities.

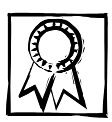
Cognitive apprenticeship

> The constructivist teacher models the process and coaches the students toward expert performance. Scaffolding, in the form of graphic organizers or other support materials, enables the learner to eventually perform the authentic tasks of experts.

The constructivist learning environment encourages the learners to construct their own knowledge, either alone or in collaboration with their peers. In this environment, the instructor serves as a facilitator in the students' learning experience, not purveyor of knowledge. It is the role of the instructor to create a safe place in which the learners can work within their own abilities to achieve a level of potential development.

This level of potential development is derived from Vygotsky's (1978) zone of proximal development, which states that student's problem-solving skills fall into three categories: skills which the student cannot perform, skills the student may be able to perform, and skills that the student can perform with help from an adult or more experienced peer. In the cognitive apprenticeship model, the learner is provided with the assistance needed, in the form of modeling, coaching and scaffolding, to achieve the level of behavioural and cognitive performance of a skilled professional.

To this aim, the following design considerations for constructivist learning environments can support *cognitive apprenticeship.*



Students, instructors, and personnel who support the learning receive appropriate training.

It is important to study the physical, organizational, and cultural aspects of the context in which the constructivist learning environment is being implemented, to ensure pitfalls are avoided which could doom its success. Constructivist learning environments are developed based on certain assumptions about the role of the learners, instructors and support personnel, which vary greatly from traditional forms of instruction.

In the constructivist learning environment, students are expected to be self motivated and autonomous in their learning. This type of learning requires specific self help and coping skills that may need to be explicitly taught to the students before instruction begins. Similarly, the instructor may require new skills to effectively take a background role in the students' learning. An instructor who is accustomed to leading a course front and centre may need to learn some new techniques to be a strong background player. Finally, the support personnel who field questions from the students in help desks can also benefit from a broad background in constructivist approaches to best assist the students in troubleshooting and reaching their goals.

Explicit training on these areas could take the form of face to face workshops or online modules. In any case, it is important that the participants feel prepared and comfortable with the constructivist learning philosophies and navigational and technical features of the constructivist learning environment before instruction begins.

Behavioural modeling of the overt performance and cognitive modeling of the covert cognitive processes assist learners in completing the tasks.

Behavioural modeling demonstrates how to perform the specified activities and cognitive modeling demonstrates the reasoning that learners should use while engaged in the activities. The constructivist learning environment provides the learner with a demonstration of a skilled, not necessarily expert, performer of the example. When learners need help performing the activity themselves, they may be able to select a “Show Me” or a “How Do I Do This?” button. It is important to point out the discrete actions and decisions made in the performance, so that the learner is not required to infer missing steps. A widely accepted method for modeling problem solving is worked examples. Using worked examples moves the learners’ attention away from the finished answer, or product, and toward the various steps in the process (Jonassen, 1999).

Cognitive modeling articulates the reflection-in-action that learners should use while engaged in the professional activities presented in the learning environment. As an experienced performer models problem solving, the person also articulates the reasoning and decision making that are involved in each step of the process. Similarly, the skilled performer can perform a post-mortem on the activity, defending the decisions that were made. This prepares learners to defend their own professional decisions, an important skill. These reflections can be recorded and incorporated into the learning environment
(Jonassen, 1999).

Coaching allows the learner to improve personal performance to reach a skilled level in task completion.

According to Jonassen, (1999) a good coach motivates learners, analyzes their performance, provides feedback and advice on the performance and how to learn about how to perform, and provokes reflection and articulation of what was learned. Students may solicit help by pushing a “How Am I Doing?” button, or the coach may offer unsolicited help.

The coach’s first goal is to engage the learner in the activity, by providing motivational prompts early on and during particularly difficult tasks. The coach may also offer hints or help by reminding the learner of steps in the task they may have overlooked, by reminding the learner of related cases to consult, or provide feedback based on the learner’s previous performance.

Another role of the coach is to force the learners to think outside of their constructed mental models. Learners often have flawed methods for solving the problems and, unless they are provoked, will not reconsider their method once it is place. The coach may prompt the learners to reflect on their actions by asking such questions as: Why did you…, What results did you expect when you…, and What if you had done …?

Scaffolding provides temporary frameworks to support learning and student performance beyond their capacities.

Scaffolding serves the same purpose that an adult or more experienced peer would serve in assisting a child perform a task that is within the zone of proximal development. In a constructivist learning environment, scaffolding provides the assistance to enable an inexperienced learner to achieve a level of proximal development. A learner may request this assistance by selecting a "Help Me Do This" button.

There are three ways that scaffolding may be provided. In the first model, the steps in the tasks are supplied for the learner, in a form of skeleton, enabling the learner to complete the task. In another form of scaffolding, the difficulty of the task is adjusted to the learner's level. Perhaps several versions of the task are available, some more difficult than others, and the learner advances through the various levels, gaining expertise at each new degree of difficulty. To assist the learner in solving the problems, related cases may be provided that serve as examples and provide novices with a substitute body of professional experience that they lack. Finally, scaffolding may take the form of different levels of expectations regarding the learner's ability to complete the task. The learner's ability may be determined in the pre-assessment phase of the lesson, and alternative forms of assessment may be provided based on the level of expertise the learner.

Process-based evaluation

In a constructivist learning environment, evaluation examines the thinking process. Therefore, it centres on two important elements, "instrumentality" and "metacognitive skills." Instrumentality implies that the perspective that each student develops in the content area is effective in working in that area. Metacognitive skills, or reflexive awareness of one's thinking, implies that the student can think about his/her thinking and defend his/her judgements. One possible type of evaluation would ask learners to address a problem in the field of content and then defend their decisions. Another might ask the learners to reflect on their own learning and document the process through which they have constructed their view of the content.

In traditional instructional design, evaluation presumes a universal goal or objective for the instruction. An exam measures the progress towards the goal and the information compiled about the students suggests the relative proficiency of the system in terms of achievement of the goal. With a constructivist view of knowledge, however, the goal is to improve the learner's ability to use the content domain in authentic tasks (Brown, Collin, Duguid, 1989). Evaluation examines the thinking process that has enabled the learner to be successful in completing the predetermined authentic task.

To this aim, the following design considerations for constructivist learning environments can support *process-based evaluation.*

Assessment tests the learning outcomes. Assessment of skills involves using the skills, not describing them verbally.

Constructivist learning approaches encourage higher order thinking, since they call on the learners to transfer the domain content to complex contexts to solve problems. Therefore, evaluation needs to link directly to the learning outcomes and assess higher order thinking, not merely behaviours or the ability to recall information.

Two elements are important to consider when assessing higher order thinking: instrumentality and metacognitive skills. Instrumentality determines the degree to which the learners' constructed knowledge in the field permits them to carry out an authentic task that they would be asked to carry out in that discipline. There is a direct link between an individual's level of domain knowledge and this person's ability to solve a problem in the field. Experts have more problem-solving skills and, hence, are better able to solve problems.

The second element, metacognitive skills, describes the learner's ability to clarify and defend decisions, or argue perspectives. Students demonstrate an ability to reflect on the process by which they have come to construct their knowledge, and articulate their process of constructing a representation of this knowledge. When learners are solving complex problems, it is sufficient to require them to articulate their solutions and then develop a coherent argument to support that solution.

Self-regulated learners assume responsibility for setting their own goals, determining their own strategies and monitoring their own learning.

Knowledge construction starts with the learner articulating an intention to build knowledge, so it is the learner who is best able to set personal goals, determine strategies, and evaluate the knowledge construction process. This evaluation process serves as a self-analysis and metacognitive tool, rather than a reinforcement and/or behaviour control tool.

Learners are assessed formatively to inform future learning experiences. Assessment is seamlessly integrated into meaningful learning experiences and not tacked on at the end.

Cognitive tools allow students to move beyond language to represent what they know in ways that are more highly structured and visual.

Communication and information technologies offer the learner a wide spectrum of presentation tools to represent knowledge visually, rather than only through language. Constructivist learning environments consider alternative forms of knowledge representation, such as two or three-dimensional representations, or other constructions, and place equal emphasis on the process and product for assessment purposes. (Beers & Goldman-Segall, 2001; Goldman-Segall, 1998). Cultures depend upon a variety of media and genres to communicate their messages, so evaluation methods need not be limited to paper-and-pen academic compositions and written examinations.

Multiple perspectives are included in the evaluation process.

Constructivist learning environments acknowledge that complex problems are made up of multiple perspectives, and multiple solutions are possible. Learning is referenced by a domain of possible outcomes, each of which provides acceptable evidence of learning. Therefore, the assumption that a single evaluator is capable of providing an objective or a complete appraisal from their single perspective is impossible.

The evaluation of the constructive learning process can be improved by adding multiple evaluators who have a range of expertise in the area being studied and who represent multiple perspectives. This allows the instructor to play a facilitative coaching role while external sources would be responsible for summative decisions.

Evaluation of constructivistic learning may suggest a panel of reviewers, each with a meaningful perspective from which to evaluate the outcomes and each with reasonable credentials for evaluating the learner. The panel may consist of novices, as well as experts. It is likely that a novice could provide a much better evaluation than the expert, who frequently focuses on inappropriate criteria for learning.

Developing constructivist outcomes

The principles of constructivism suggest several best practices for the creation of learning outcomes. Outcomes are a necessary part of module planning. They provide learners with an indication of the domain knowledge they will be exploring, and place an initial emphasis on higher-order thinking and metacognitive skills. For additional information on writing outcomes, access BCIT's "How to" available online at: http://www.lru.bcit.ca/instructors/resources/development/shtm/.

Outcomes include metacognitive as well as instrumental outcomes.

Two types of outcomes are significant in constructivist learning environments: outcomes involving practice of a skill in the field (instrumental outcomes) and outcomes related to the process of the construction of knowledge (metacognitive outcomes).

Metacognitive outcomes describe students' enhanced ability to reflect on their learning processes, and to modify their goals and approaches in response to new experiences as they build knowledge. Learners develop expertise in thinking *on* action, as well as *in* action. The ability to think *on* action – for learners to reflect on the process they have followed and take steps to improve it or apply it elsewhere – is part of being a self-regulated learner. Self-regulated learners take responsibility for a range of skills: identifying learning needs, setting goals, managing time, selecting activities and evaluating progress. Learning outcomes may include a specific focus on these self-management skills.

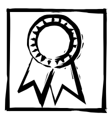
Instrumental outcomes are based on using skills to perform authentic tasks, not describe them. Outcomes go beyond asking learners to recall information they encountered as part of the lesson. This type of recall is fairly easy to accomplish, but is unlikely to lead to lasting knowledge development. Performance of authentic tasks may require learners to acquire new vocabulary or understanding of particular processes. The outcomes are aimed squarely at the "why" of the need for such knowledge acquisition: the ability to perform a task at an expert level.

Outcomes focus on high-level thinking skills.

In both cases, outcomes focus on high-level skills, not simply information recall and comprehension.The outcomes appropriate for describing either focus are generally those found on the levels of Bloom's taxonomy of cognitive skills: abilities to analyze, synthesize and evaluate. This focus on the higher-order thinking recognizes that not all outcomes will be interpreted in the same way by all learners.

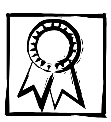
For example, consider the difference between “evaluate the effectiveness of a presentation” and “apply presentation guidelines to a sample presentation.” In the first outcome, one can imagine different learners applying different criteria to the presentation, depending on their level of knowledge, their experience of the topic of the presentation and myriad other factors. The second outcome suggests constraints on the anticipated learning. One would anticipate a fixed list of factors, pre-selected by an instructor as most relevant for the task at hand.

The second approach more closely mirrors that of traditional education. It tends to limit exploration of new content, and puts the focus on recall and summary of the information presented. Unfortunately these specific components are less likely to be remembered and thus less likely to be useful for learners later than a process for evaluation that they themselves have developed. The performance of an authentic task – evaluating a presentation, just as they might evaluate a presentation they or a colleague has made in a professional situation – contributes to the memorable nature of the task and helps ensure the knowledge developed can be transferred to a new situation.



Outcomes allow for multiple approaches to knowledge construction.

The constructivist theory of learning suggests that learners will find a path through information and construct knowledge in their own way, whether the instructor and course planners recognize this or not. Not all learners will find relevance in all details presented as part of a course or a module. Some material may already be well known to them: other details may be irrelevant to their situation, or so far from their realm of knowledge that they cannot recognize their importance. Outcomes may indicate a destination for learners, but they do not dictate the route required to get there.



Learners are involved in the development of learning outcomes.

Involving learners in the identification of outcomes is challenging in the e-learning environment. Course materials must be prepared in advance, not once the students arrive, and students do anticipate and deserve a course that is well-planned and organized. There are ways to involve learners in outcome development, however, that do not lead to chaos. Learners should be involved in formative and summative assessment of their process towards a learning goal. In cases where content is dictated by external requirements, learners may be asked to set an individual learning goal to go along with the goals required by the instructor.

Putting the pieces together: Lesson planning

Principles of constructivism inform all stages of the lesson, from the pre-assessment to the final evaluation. For additional information on lesson planning, access BCIT's "How to" available online at: http://www.lru.bcit.ca/instructors/resources/development/shtm/.

Lesson components are referenced to learning outcomes.

The learning outcome or outcomes provide a framework for all other aspects of the lesson. Pre-assessment activities not only provide the instructor with an opportunity to evaluate the status of students' current knowledge, they also motivate students to make a commitment to constructing new knowledge. The presentation of new concepts, ideally done in multiple ways, gives them an opportunity to explore and apply information, assembling the knowledge and achieving the outcome in their own way. Opportunities to make connections allow for articulation of the links between what is already known and what is new. Reflective activities give students an opportunity to consider the process by which they have constructed their knowledge of the concepts.

Evaluation is of two types, formative and summative. Formative evaluation may occur at several points in the lesson. It provides students with an opportunity to articulate the knowledge they are constructing, to share their perspective with their peers and with the instructor, and to refocus their knowledge-building activities. Summative evaluation, or post-assessment, provides a stopping point, not a final destination. It is an opportunity for students to consolidate and demonstrate the skills they have acquired, and articulate the metacognitive processes they have used to acquire them.

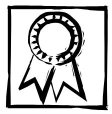
Pre-assessment

Pre-assessment activities motivate students to make a commitment to constructing new knowledge.

Since individuals construct their own knowledge based on what they already know and their experience of new concepts, the pre-assessment phase serves two purposes. Pre-assessment gives students an opportunity to call to mind knowledge they already have that can be built on with knowledge of new concepts. The pre-assessment activities encourage them to begin the process of constructing new knowledge by identifying areas in which they are not knowledgeable.

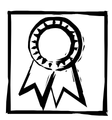
The activities may suggest ways the new material connects to their knowledge. Personal analysis of their experience with pre-assessment activities assists learners in the development of individual goals for learning.

Introducing new concepts



Multiple entry points into new concepts allow for individual knowledge construction.

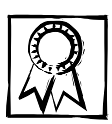
Individuals construct new knowledge based on the knowledge they already have. A single entry point to a new concept limits access for those who are approaching from different cognitive directions and with different experiences. For example, many individuals within an organization may need to use a database. Each individual's approach to learning to use the database will be determined by their previous knowledge and experience, and can be expedited by providing multiple entry points reflecting those differences in experience. An office assistant skilled in word processing may most easily learn to use the database if it is approached through a text screen, and if the information provided reflects the similarities between the database and the word processing program. A financial analyst may have no previous knowledge of word processing, and could learn more about the database by building on knowledge of spreadsheets.



The lesson allows for multiple points of view.

The introduction of differing points of view pushes learners to articulate not only their view, but also the reasoning that supports it. This analysis encourages higher-order thinking.

Experts in a particular area have a rich knowledge of multiple perspectives on issues within their field, and can draw on these perspectives to solve problems. Introducing multiple points of view gives learners an opportunity to develop a more nuanced view of a given outcome.



The lesson articulates the components of the instrumental skill, including the cognitive processes used by an expert practitioner of the skill as the skill is used.

Learners need to learn the why, not only the how, of the skills they are acquiring. Expert articulation of the skill as it is being performed provides the "why" component, and exposes the process to scrutiny as it is being learned. The articulation of the process helps to eliminate the sense of professional knowledge as an unknowable black box.

The lesson introduces new concepts in the context in which they will be used.

Knowledge exists in a context: think of the different meanings of "knowledge of anatomy" for a physician, a toxicologist and a figurative artist. Professional knowledge is applied knowledge—knowledge in use. It is not the ability to describe a concept in isolation that is useful, but the ability to use the concept to perform a required task. Since the learning outcome goes beyond repetition of information and calls for application of knowledge, the context is a crucial component.

Student activities are authentic, mirroring the tasks performed by experts.

The lesson provides, as much as possible, exposure to the expert community of practice where the skill is applied. This may be done through actual encounters or through media presentations.

The lesson does not consist of learning activities that are done only in educational settings: matching words to definitions, writing definitions of terminology, and other similar tasks. Rather, the tasks learners are asked to perform resemble the tasks performed by experts in the field.

When necessary, scaffolding is provided so learners can perform skills they have not developed sufficient individual knowledge to perform.

If learners have not yet achieved the learning outcome, they will not be able to perform the task without assistance. Scaffolding is provided where necessary to allow learners to experience the application of higher-level skills before they have developed the skills as individuals. Scaffolding may be provided by the instructor, by learning materials, by peers or by experts in the field (for example, in a clinical placement).

The lesson provides opportunities for learners to evaluate their progress.

Learners have an opportunity to reflect on their personal goals and strategies, and make modifications if they feel it is necessary.

Reflection

Reflection begins in pre-assessment, and is the basis for knowledge construction beyond the post-assessment.

Beginning in the pre-assessment phase, learners set their own goals based on their reflections on the new concepts to be learned, and the knowledge they have already. Once the post-assessment phase is reached, learners reflect on what they have discovered and set new goals for learning.

Reflective activities give learners an opportunity to consider metacognitive processes and instrumentality.

Reflective activities are structured and occur as part of the lesson. They frequently ask learners to articulate their thoughts and consider how they reached their conclusions.

Post-assessment

Post-assessment matches the learning outcomes for the lesson.

Post-assessment focuses on higher order thinking skills and articulation of processes and the reasoning behind them, rather than information recall and performance of behaviours without indication of understanding of underlying logic.

Assessment focuses on instrumentality and metacognitive processes.

From a constructivist perspective, learners aiming to achieve a learning outcome are simultaneously doing two things: they're learning the skill itself, and they are learning the thinking process required to develop and apply the skill. Post-assessment activities should focus on both branches. For example, a post-assessment activity may ask learners to solve a problem, and also to articulate the process they used to solve the problem. Post-assessment activities should not ask learners to simply recall information or perform a measurable behaviour in isolation from the thinking that underlies it.

Assessment recognizes variety in individual construction of knowledge.

There are many ways to demonstrate knowledge, and assessment provides learners with an opportunity to demonstrate their knowledge in the way that makes most sense to them.

Assessment recognizes the validity of multiple perspectives.

Assessment activities allow for the contribution of other perspectives, not only that of the instructor. Since knowledge is constructed individually, it is not assumed that the instructor has exclusive knowledge of the One Right Way to evaluate learning. There may be places for input from peers, from other experts and for the learners themselves to evaluate the accomplishment.

Assessment is both formative and summative.

Evaluation activities built into the lesson provide learners with an opportunity to consider their own learning skills and their growing skill mastery. This allows them an opportunity to re-focus if necessary, refining goals and changing strategies to enhance learning.

Selecting learning activities for all lesson phases

The following section, “Constructivist learning activities: imagine the possibilities!” provides several options for learning activities at each phase of the lesson. In some cases one activity will be sufficient. In others, particularly in the introduction of new concepts, it may be important to include multiple activities.

Examples from the field: Constructivist learning in action

Reciprocal teaching (low tech example)

Brown and Pulincsar (1984) investigated a technique called "reciprocal teaching" intended to improve the reading skills of learners. Sophisticated readers use a number of techniques to ensure their comprehension of a text. They question what they read, clarify what they don't understand, summarize what they've read so far and predict what may come next. Those who do not read well typically do not have these skills, and are not aware of them.

A reciprocal teaching activity involves a small group of readers, including an instructor, reading from a work. Instructor and students take turns leading a discussion on a text. The discussion leader first asks the group questions based on the text. If there are disagreements on the answers, the group seeks clarification within the text itself. The leader ends the segment by summarizing the text, and asking everyone to predict what might come next. The instructor acts as the first discussion leader, and then coaches learners as they take turns as leaders. Reading continues, with each learner and the instructor taking continued turns.

The instructor:

- Models expert behaviour, thus making comprehension techniques explicit
- Sets learning goals
- Provides feedback and coaching to learners
- Transfers responsibility for comprehension to students as soon as they can accept it

The students:

- Lead their own discussions
- Participate in the discussions led by others
- Critique the discussions led by themselves and others

Brown and Pulincsar found considerable improvement in student reading comprehension. They credit the improvement to the requirement that students "are forced to articulate their knowledge about what makes a good question, prediction or summary. This knowledge then becomes more readily available for their own summaries and questions, thus improving a crucial aspect of their metacognitive skills. Moreover, once articulated, this knowledge can no longer simply reside in tacit form. It becomes more available for performing a variety of tasks; that is, it is freed from its contextual binding and can be used in many different contexts." (p. 464)

Application of the seven principles

Construction of knowledge

Learners resolve problems collectively by formulating and testing hypotheses.

Process not product

The focus in this activity is on collective comprehension of a passage of text and the application of expert tools to the development of comprehension, rather than on correct answers to the questions posed about the text.

Multiple perspectives

Since this work is carried out in groups and all participants are actively involved, multiple perspectives are brought to bear on the reading. The summary and other statements produced by the leader are also critiqued.

Situated cognition

Success in education generally requires high levels of reading comprehension. The reading comprehension skills practiced in this example are among those necessary in the academic environment. The presence of a successful model – the instructor – helps to situate the skills within the appropriate context.

Reflexive cognition

Students evaluate and reflect on their own use of the tools of comprehension, and the use of the tools by others, throughout the process. The process requires them to predict what may come next in a text and then read for themselves to check the accuracy of their theory. When questions are posed and answered, learners are prompted when necessary to provide the supporting documentation for their answers thereby articulating the process by which they answered the question.

Cognitive apprenticeship

In this activity students are clearly the instructor's apprentices. The instructor's role includes identifying the sophisticated interpretive skills used by expert readers, modelling those skills, and providing coaching to learners as they try the skills themselves. Students are encouraged to assist each other, and to communicate their understanding.

Process-based evaluation

Formative evaluation occurs throughout this procedure, as participants evaluate each other's summaries and investigate and clarify misunderstandings on the spot. It is the use of the tools for comprehension that is critiqued, not that which is comprehended.

Evaluating assessment techniques (high-tech example)

Oliver, Herrington, Herrington and Sparrow (1996) designed an activity to give pre-service mathematics teachers access to authentic information about in-class assessment methods. Pre-service teachers in mathematics education are given an assignment to create a report on effective methods of in-class assessment for students. The pre-service teachers were asked to imagine that they had been newly hired by a school and asked by the principal to perform the task. The students worked in groups of three. Each trio was asked to assume that they had been asked by the principal of the school where they had just been hired to explore assessment techniques at use in the school, and report on their findings at a staff meeting.

The "school" was represented by a multimedia CD-ROM. The collection included:

- Video clips of classroom episodes in which various forms of assessment are used
- Video interviews with the teachers, in which they reflected on their use of the technique
- Video interviews with students, in which they reflected on their experience of the technique (in some cases)
- Virtual filing cabinets containing samples of student work evaluated by each method (when appropriate)
- Expert commentary (audio) on each assessment technique

As teams progressed through the term, they were encouraged to reflect continuously on what they had discovered so far, and what else was needed to complete their report.

Application of the seven principles

Construction of knowledge

Beyond the bare outlines of the tasks and a model provided by the instructor, students were required to plan their own approach to the materials. There was no sequence of steps they were expected to follow.

Multiple perspectives

Multiple perspectives were provided in several ways. Each assessment technique was seen in action, discussed by the teacher who used it, and discussed by an expert. Students worked with colleagues to complete the assignment, thus bringing multiple perspectives to bear on interpretation of what was seen.

Process not product

Working with colleagues to explore the multiple possible paths through the material keeps the focus on process. To complete the project and create final reports, students were required to make judgements about the materials.

Situated cognition

The use of multimedia enabled the designers to bring the high school and elementary school classroom to the pre-service teachers. Rather than reading descriptions of assessment techniques, they were able to view them in the context of the classroom. Using multimedia meant that each group was able to view and consider many more examples than would have been possible by direct observation.

Reflexive cognition

Working in groups required the students to continuously articulate their knowledge. They were also provided with an electronic notebook to use in the context of the CD-Rom, enabling them to easily reflect on what they were seeing in the videos, etc. in a systematic way.

Cognitive apprenticeship

The process begins with the instructor modelling what is expected, and the instructor remains available as a coach throughout the process. The video clips of expert teachers reflecting on assessment techniques also serve as models.

Process-based evaluation

The final presentation, at a simulated staff meeting, provided students with an opportunity to articulate their knowledge and describe the approach they took to reach their conclusions.

Constructivist learning activities: Imagine the possibilities!

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Pre-Assessment: • Knowledge builds on what is already known • Opportunity for learners to demonstrate what they already know • Opportunity for instructors to identify areas where information/practice opportunities are needed						
Pre-Assessment	**Questions**	Oral quiz Written quiz	Telephone quiz Online quiz		Multimedia decision tree	
	Learner skill demonstrations	Demonstrate skill in face-to-face environment with authentic material or model Explain skill	Videotaped demonstration of student's skill		Webcast demonstration of skill by student Computer based simulation	*Seriousmagic*™
	Discussions	Face-to-face Telephone	E-mail Teleconference Synchronous or asynchronous discussion forum Video conferencing		Desktop video conferencing Virtual meeting	*Meeting Zone*™ *Net Meeting*™
	Brainstorming	White board/flip chart	Conference call		Text synchronous chat (recorded) Virtual meeting	*Meeting Zone*™ *Net Meeting*™

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Introducing New Concepts: • Includes process of challenging misconceptions which may have been identified in pre-assessment • Introduces multiple perspectives, not The Truth • Authentic activities that allow learners to experience, rather than presentations that tell						
Introducing New Concepts	**Experimentation**	Lab, mock lab	Streaming video of lab experiment		Computer-based simulations	
	Observations	Field trips Observe role play Observe in-class demonstration	Video/film Streaming video		Interactive demo (ie. CD-Rom made with Director)	*Director™*
	Research with secondary sources	Books and journals	Online journals eBooks		Relational database	
	Tours	Field trip	Video/film Virtual visits		Virtual visits with increased interactivity/technical sophistication	*QuickTime VR™* *PowerPoint Producer™* *Impatica™*
	Problem solving (presentation of problem or case)	Text scenario	Video scenario Virtual panoramic tour Audio scenario		Hyperlinked video scenarios with multiple perspectives Multimedia case studies Document sharing	*PowerPoint Producer™* *LiveLink™*

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Introducing New Concepts	**Problem solving (finding solutions to problem or case)**	Face-to-face problem solving in groups	Problem-solving in groups using e-mail, phone, discussion forums, chat, digital shared white board		Knowledge clustering Computer-based simulations	*Orion™ (beta)* *Thoughtscape™* *Impatica™* *Director™* *Flash™*
	Advance organizers	Learning plan Skeleton class notes Graphic aids, slides	Online outline/graphics Expanding navigational bars		Expanding navigational bars with tracking Breadcrumbs	
	Discussions	Face-to-face	E-mail Teleconference Listserv Asynchronous or synchronous discussion forums Video conferencing		Desktop video conferencing Virtual meeting with voice over IP	*Meeting Zone™* *Net Meeting™*
	Debates	Face-to-face	Teleconference Listserv Asynchronous or synchronous discussion forums Video conferencing		Desktop video conferencing Virtual meeting with voice over IP	*Meeting Zone™* *Net Meeting™*

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Introducing New Concepts	**Interviews**	On-site, face-to-face Telephone	E-mail Teleconference Asynchronous or synchronous discussion forums Video conferencing		Desktop video conferencing Virtual meeting with voice over IP Webcast	*Meet Zone™* *Net Meeting™*
	Discrepant event	Observation Documented event from mass media Account of event	Video/film Online account of event		Computer-based simulations Multimedia presentation	
	Expert demonstration/ modelling	On-site demonstration	Video/film Video conference (real time) Demonstration		Share application Virtual meeting Animation	
	Direct instruction	Lecture Text Co-operative learning activities (e.g. jigsaw) Presentation	Video/film Online co-operative learning Online presentation	*PowerPoint™* *Impatica™*	Online tutorial Interactive lecture	*SLATE™ (beta Shared Learning and Teaching Environment) from Silicon Chalk* *PowerPoint Producer™* *Flash™*

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Making Connections: • Between known and new • Between educational activities and real-world applications						
Making Connections	**Concept-mapping**	Notebooks, flip chart	Computer-based mind mapping	*Inspiration™*	Knowledge clustering	*Thoughtscape™* *Orion™ (beta)*
	Interaction with experienced practitioner	Guest speaker with question and answer session	E-mail Teleconference Listserv Asynchronous or synchronous discussion forums Video conferencing		Desktop video conferencing Virtual meeting	*Meeting Zone™* *Net Meeting™*
	Pattern identification over time	Real-time observation	Documented and archived events		Online video observation with documentation features (time-coded, annotated)	
	Problem solving (presentation of problem or case)	Text scenario	Video scenario Virtual panoramic tour Audio scenario		Hyperlinked video scenarios with multiple perspectives Multimedia case studies Document sharing	

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Making Connections	**Problem solving (finding solutions to problem or case)**	Face-to-face problem solving in groups	Problem-solving in groups using e-mail, phone, discussion forums, chat, digital shared white board		Knowledge clustering Computer-based simulations	*Orion™ (beta)* *Thoughtscape™* *Impatica™* *Director™* *Flash™*
	Narrative	Text Skit or play	Video/film Audio narration		Interactive multimedia presentation Animated characters Use of agents	*PowerPoint Producer™* *Flash™*
Reflection: • Opportunities for reflection can be built into all parts of lesson • Gives learners an opportunity to consider ways in which their knowledge has developed • Consolidation, preparation to move forward to next phase of learning						
Reflection	**Journals**	Notebooks E-journal	Weblogs Personal Digital Assistant		Annotated multimedia journal Knowledge clustering	*Thoughtscape™* *Orion™ (beta)*
	Discussion	Small group, face-to-face	Teleconference Chat rooms Listserv Asynchronous discussion forum		Desktop video conferencing Virtual meeting with voice over IP	*Meeting Zone™* *Net Meeting™*

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Reflection	**Role playing**	Face-to-face Telephone	E-mail Asynchronous or synchronous discussion forum Video conferencing Teleconference		Desktop video conferencing Virtual meeting with voice over IP	*Meeting Zone*™ *Net Meeting*™
	Peer review/ feedback circle	Face-to-face Written Telephone	Online survey E-mail Asynchronous or synchronous discussion forum Video conferencing Teleconference		Desktop video conferencing Virtual meeting with voice over IP	*Meeting Zone*™ *Net Meeting*™
	Plotting personal development	Notebooks E-journal Flow chart Concept map Portfolio	Web log Electronic flow chart electronic concept map	*MSWord*™ *Inspiration*™ *Blogger*™	Interactive multimedia portfolio	
	Video ethnography	Creating and relating to VHS video	Creating and relating to digital video		Annotating, clustering and sharing digital videos	*Orion*™ *(beta)*

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Post-Assessment: • Focus on how the learner is able to apply knowledge, think like an expert and perform tasks as an expert would • Focus on reviewing or demonstrating a process rather than production of a product • Collectively-determined evaluation methods; the student and instructor together determine when a learning goal has been reached						
Post-Assessment	**Portfolios**	Notebooks E-journal Flow chart Concept map Portfolio	Web log Electronic flow chart Electronic concept map	*MSWord™* *Inspiration™* *Blogger™*	Interactive multimedia portfolio Knowledge clustering	
	Presentation	Lecture Text Co-operative learning activities (e.g. jigsaw) Presentation	Video/film Online co-operative learning Online presentation	*PowerPoint™* *Impatica™*	Online tutorial Interactive lecture	*PowerPoint Producer™* *Flash™* *Director™* *Impatica™* *Seriousmagic™*
	Report	Individual report	Online		Multimedia report	*PowerPoint Producer™* *Flash™* *Director™*

LESSON PLAN PHASE	LEARNING ACTIVITY	Low Tech Delivery	Mid Tech Delivery	*Mid Tech Software Possibilities*	High Tech Delivery	*High Tech Software Possibilities*
Post-Assessment	**Problem solving (presentation of problem or case)**	Text scenario	Video scenario Virtual panoramic tour Audio scenario		Hyperlinked video scenarios with multiple perspectives Multimedia case studies Document sharing	
	Problem solving (finding solutions to problem or case)	Face-to-face problem solving in groups	Problem-solving in groups using e-mail, phone, discussion forums, chat, digital shared white board		Knowledge clustering Computer-based simulations	*Orion™ (beta)* *Thoughtscape™* *Impatica™* *Director™* *Flash™*
	Learner skill demonstrations	Demonstrate skill in face-to-face environment with authentic material or model Explain skill	Videotaped demonstration of student's skill		Webcast demonstration of skill by student Computer based simulation	*PowerPoint Producer™* *Seriousmagic™*

Beyond the e-learning module: Infrastructure requirements for e-learning

Before …

I've been asked to develop an online course. How do I get started?

- Use a team approach when developing an online course. Multiple perspectives help to ensure quality. Many different skills are required to create a successful course. Team members may include an instructional designer/technologist, technical support staff, graphic artist, media specialist, writer, and quality assurance editor. (See Appendix A Project Team for Online Course Development for roles of specific team members.)
- Follow a systematic approach to instructional design when developing an online course. One example is shown below: (See Appendix B Online Course Project Plan Checklist.)

Needs assessment

Assess the feasibility of the new online course and justify the development for all stakeholders and funding sources. Possible questions to consider are as follows:

- Is there a demonstrated market demand for the online course?
- What is the profile of the learners? (location, technical abilities, etc.)
- Does the course have the approval of the stakeholders?
- Is there budget and funding approval for the development, marketing, and delivery of the course?

It is also important to consider:

- Does this course currently exist in a face-to-face and/or traditional distance education format? If so, what is the current state of the materials? (This is helpful in determining the amount of development time is needed. See Appendix C Online Preparation Inventory.)
- Has the instructor for the new online course been identified? If so, assess the level of the instructor's online readiness in order to determine the amount of orientation, training, and/or professional development is needed. (See Appendix C Online Preparation Inventory.)

Design your course plan

- See Appendix D Online Course Plan worksheet and use the ideas from this document to create a course plan.
- Refer to Constructivist learning activities: Imagine the possibilities! To help select interactive learning activities.
- Meet with project team members to review course plan.

Develop a prototype

- Choose a module (or unit) that contains a variety of learning activities to use as a prototype.
- Develop the all learning activities, content, multimedia components, and student evaluation instruments for the prototype module. Upload these components into the course management software.
- Use Ensuring Usability for Online Courses as a guideline when developing the prototype.

Evaluate prototype

Conduct a technical and instructional review of the prototype. The reviewers of the prototype can be other instructors in the program, potential students, project team members, and industry sector personnel.

Revise

- Meet with the project team to discuss the results of the prototype review.
- Revise the course plan and prototype as necessary.
- Revise the project timelines as necessary.

Develop course materials

Complete the development of the course materials based on new course plan.

Final review

Conduct a final review of the completed course.

Implement

Deliver the course to students. Consider a "pilot" offering at a discounted rate the first time the course is delivered in exchange for feedback from the students.

Evaluate and revise

Analyse feedback from students and revise accordingly.

How will student IDs and passwords be generated for the course management tool when a student registers for an online course?

- Find out if student IDs and passwords are automatically generated by your institute's registration system. In order for this automation of IDs and passwords to occur, your institute's registration system must "talk to" your course management system.
- Be aware that some automated systems give students immediate access to online courses once the student has registered for a course. This may be a problem if the course is not actually ready until the course start date.
- If this automation does not occur, identify who will be responsible for generating IDs and passwords and entering them into the course management system.
- It is important to note that some course management systems display student IDs for all course members to see. If so, this may violate student privacy.

How will students be notified of course access information such as ID, password, and URL?

- Notification should include URL for course, student ID and password, technical assistance information, and confirmation of registration.
- Notification can be made via email. Be sure to request student email information during registration process. Avoid using the course management email tool for notification.
- Notification can be made via regular mail if supplementary materials are being shipped out to students.

What will be the cost to students of an online course?

- Keep costs in line with face-to-face courses of same credit value.
- Some institutes add a small technology fee to help cover the costs of maintaining a help desk.

- Be aware that printing costs may now be passed on to the student in an online course. (Handouts that they would have received in a face-to-face course are now put online for students to print.)
- When offering an online course for the first time you may want to offer a special "pilot" rate for the students in exchange for their feedback on the course.

How will students receive/return supplementary materials?

- An online course does not have to mean that all materials go online. Some materials (such as textbooks and CDs) can be shipped out to the students. Identify the person who will be responsible for getting these materials to students.
- Ensure timelines for ordering and shipping supplementary materials can be met prior to course start date.
- Identify process and procedures for the return of textbooks and materials (if applicable) when a student withdraws from a course.

Who will be responsible for hosting your institute's online courses and maintaining the course management software?

Courses can be hosted on a server within your institute or externally through a private hosting organization. Either way, ensure that the person responsible considers the following:

- The server should be housed so that it is a direct-connect to the network backbone.
- Be aware of firewall issues. Some students may not be able to access your course from their workplace due to firewalls. This may be resolved by moving course access to a different port.
- Consider a test server for testing upgrades and patches to your course management software without disturbing live courses.
- Any upgrades and/or patches that must be applied to the course management software should be completed during non-peak hours.
- Consider using monitoring software that will enable you to determine peak and non-peak course access times. This can help when scheduling the best time to apply software patches and for scheduling student help desk personnel.

- Consider a monitoring service that "calls" in to the server to constantly monitor the server's performance level. If performance levels are low or inaccessible, someone can be contacted to troubleshoot the problem.
- Ensure that the server is backed-up on a daily basis. The back-up can then be used in case the server crashes and data is lost.

How will instructors access training to use course management software?

- Training may include online tutorials and/or face-to-face workshops.
- Instructors may need to become familiar with the challenges of teaching and learning at a distance, not just the course management software.
- Consider setting up practice courses for instructors to experiment with course management software tool(s).

Now that the course has been developed, what should I do as an instructor prior to the course start date?

- Familiarize yourself with the course management software tool(s).
- If you are not the developer of the course, spend some time familiarizing yourself with the course materials and learning activities.
- Ensure that links within the course are still active and that their content is still relevant to the course.
- Review assignment due dates. Consider making due dates on a Monday or Tuesday evening in order to give students the weekend to complete assignments. This is also helpful if you do not have technical support for students during the weekend.
- Set the tone of the course by posting a personal profile (brief biography) and/or sending a welcoming email message to all students. Asking students to respond to your email and post their own profile helps to familiar students with the online environment while also creating a learning community.
- Set response time expectations, for email inquiries and discussion postings, early within the course. In general, people expect a response to an email message within 24 hours. This may not be practical for instructors. Some instructors provide a response to email inquiries within 48 hours. Others may state that they will check email every Monday, Wednesday, and Friday—no weekends. Whatever the case, be sure that this is clearly communicated to students.

- Review best practices for moderating online discussions and coordinating other interactive activities to ensure active participation. There are many online resources available: the e-moderator's homepage, organized by Mauri Collins and Zane L. Berge, (http://www.emoderators.com/moderators.shtml) is a good starting point.

During…

How will students be supported if they experience technical difficulties in an online course?

- If possible, have a help desk available for students to contact in case of technical difficulties. Ideally, the help desk should be available when the majority of students are actually in their online course. (Check the server peak times for this information.) However, some help desks are only available Monday-Friday during regular office hours. Consider extending help desk hours during start of term when students experience the most technical difficulties.
- Be aware that the help desk should only support technical issues (such as: unable to login, student can't remember password or connectivity issues). Any instructional issues should be deferred to the instructor in the course.
- Avoid having instructors deal with the technical support issues of an online course. Instructors should refer students to the help desk for technical issues.
- Keep a FAQ web site for students to use to troubleshoot any technical problems they may be experiencing.
- Consider a brief face-to-face or online tutorial to help the students get familiar with the course management software.
- If possible, allow early access into the course so that the students can familiarize themselves with the course and the navigation of the software.
- What will happen if a student withdraws from an online course?
- Identify who will be responsible for denying access to the course once a student has dropped from the course.

After…

When the course is over, how will course information be archived?

- Identify a system for archiving an online course once it is completed. Who will do the archiving?

- Consider storing archived courses on CDs to save on server space and for easy access later.
- Be aware of the appeal process for student marks in your institute since it may have an impact on how long records must be stored.

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Appendix A — Project Team For Online Course Development

A. Background Information	
Course: ______________________	**Development Start Date:** ______________
Program: ______________________	**Completion Date:** ______________________
Department: ____________________	**First Offering Date:** ___________________

B. Project Team	
IDC: ____________________________ phone: ______________	**Instructional Design Consultant (IDC):** • Provides project management • Documents process and obtains sign off • Coordinates developer orientation and PD • Sets up and coordinates project team • Supports quality instructional design of course
Technical Liaison: ____________________ phone: ______________	**Technical Liaison:** • Sets up course in the Learning Management System (LMS) • Provides technical support as consulted • Ensures course uploaded according to set standards • Provides technical support for WebCT tool configuration • Participates in technical review
QAE: ____________________________ phone: ______________	**Quality Assurance Editor (QAE):** • Conducts technical usability review of prototype and completed course • Makes recommendations based on reviews
Technical Writer: ____________________ phone: ______________	**Technical Writer:** • Writes content as needed • Edits existing content • Edits materials for presentation on WWW • Participates in technical review as needed
Graphic Designer: ____________________ phone: ______________	**Graphic Designer:** • Recommends graphic design for course • Consults on non-standard style guide • Participates in technical review as needed
Technical Illustrator: __________________ phone: ______________	**Technical Illustrator:** • Designs and develops graphics for course as needed • Edits existing graphics • Edits graphics for presentation on WWW • Participates in technical review as needed
Other: ___________________________ phone: ______________	
Other: ___________________________ phone: ______________	

B. Project Team—Department	
Developer: ________________________________ phone: ____________________	**Developer:** • Coordinates with IDC to complete project • Works with project team to ensure educational and technical quality of course • Provides course materials • Participates in online development • Acknowledges results of technical and instructional reviews • Coordinates with program and/or department regarding course content and design • Coordinates with program and/or department regarding administrative issues
Program Assistant: __________________________ phone: ____________________	**Program Assistant:** • Coordinates administrative issues involved in developing and piloting course
Instructor: _________________________________ phone: ____________________	**Instructor:** • Reviews prototype and complete course • Prepares for piloting of course
Program Head/Chief Instructor: ____ phone: ____________________	**Program Head/Chief Instructor:** • Ensures department/program support for project
Other: ____________________________________ phone: ____________________	
Other: ____________________________________ phone: ____________________	

Notes:

Appendix B   Online Course Project Plan Checklist

√	Task Completed	Key Person(s)	Target Date	Comments/Resources
	First meeting re scope & support	Instructor IDC		
	Instructor orientation & training in the Learning Management System (LMS)	Instructor IDC		
	Team meeting(s)	IDC		
	Program Assistant—critical administrative tasks	Instructor & PA		
	Course plan	Instructor IDC		Refer to Appendix D Online Course Plan
	Prototype	Instructor IDC Tech		Contains a variety of learning activities preferably not the first module in the course.
	Prototype review	Instructor IDC Tech Other(s)		
	Course plan revisions based on prototype review	Instructor IDC		Update Appendix D Online Course Plan
	Course writing e.g. learning activities, content, etc.	Instructor		Consult with IDC if required
	Uploading	Instructor or Tech		
	Final review	Instructor Tech QA		
	Final revisions	As needed		

Appendix C — Online preparation inventory

This inventory is designed to help explore your readiness to convert an existing classroom course to a course delivered, all or in part, online using a learning management system. Its purpose is to aid estimating of time and resources needed for development conversion.

Instructor/Developer ________________________________ Date ____________________
Course Name and Number ______________________________ Date ____________________

Instructor Readiness	Y/N	Comments/Action
Have you ever taken any **online** course as a student?		
Are you familiar with any learning management system?		
Have you taken any workshops about online learning?		
Do you have **regular access** to the internet and e-mail?		

State of Course Materials	Y/N	Comments/Action
Is your course a full, field-tested print-based Distance Education (DE) course already?		
Do you have a current course outline (description, goals, learning outcomes, and evaluation)?		
Do you have an existing outline or schedule of course topics?		
Do you have handouts and/or PowerPoint presentations? Are handouts original or copyrighted material?		
Is there a required textbook(s) for the course?		
Have you developed an unpublished student manual or reading packet that contains most of the course content?		
Do you have descriptions of each course assignment?		
Do you have quizzes and exams prepared?		
Do you use videotape or audiotapes in the course?		
Do you have a current, active website that supports this course?		
Do you have website references (a “webliography”) for the course? Are these links still current and active?		
Does your course require specialized software programs?		
Are other course materials needed or available?		

Appendix D

Online Course Plan

Course Name and Number:	Course Developer(s):

Module # & Week(s)	Learning Outcomes and Content Topics	Learning Activities	Resources	Evaluation Method	LMS Tools
	Related learning outcome from course outline and content topics to be covered for a given week	Describes student learning activities: reading, case study, PBL, self-directed exercise, team project, written assignment, research report, etc.	Resources needed for each module: textbook pages, handout, new content to be written, URL links, etc.	Identifies: types of written quizzes and tests, participation, self-tests, papers and percentage of total.	Type of tool(s) required: discussion, content module, e-mail, assignment tool, quiz tool, etc.
1. ( )					

Appendix D (continued) Online Course Plan

2. ( )					
3. ( )					

Appendix E — Snapshot

HIC partners' technological capabilities

In May of 2002, BCIT coordinated a Technology Inventory of HIC partner institutions. The Inventory asked HIC partners to share information on the online learning technologies in use within their programs and within their institutions.

The technology inventory was intended to serve two purposes:

- To provide a snapshot of the use of online educational technology by partner institutions
- To contribute to the identification of best practices methodologies for e-learning

The summarized information from the Inventory was made available to HIC partners as it was collected, providing other project teams within the overall project information on the technological sophistication of the partners as a collective. Six participating institutions completed the inventory: University of Alberta, Michener Institute for Applied Health Sciences, BCIT, Dalhousie University, University of Sherbrooke, and University of Western Ontario.

Based in part on Inventory results, the BCIT team developed guidelines for HIC partners to gauge preparation for ideal online course delivery. The section, "Beyond the e-module: infrastructure requirements for e-learning" provides these guidelines. The guidelines are directed at two often distinct groups: course developers, and instructors who have not necessarily developed the course they will be teaching themselves.

The considerations addressed here go beyond the necessities for preparation of the e-learning modules and consider infrastructure and technical issues important to those who plan to deliver courses and programs online.

The current snapshot: HIC partners May 2002

Courses currently offered

- Approximately half of the partners currently offer health informatics courses online.

Software in use

- Partner institutions use various platforms to deliver courses. WebCT was, at the time of the survey, the most commonly-used commercial platform. Most institutions used Web pages to deliver content.

Technology in use

- Learning objects and repositories were not in use, with the exception of one institution.Partners potentially have access to more delivery, course, communication and multimedia tools than they are currently using. In many cases, tools are available at the institution level not necessarily available in the program.
- None of the partners use profiling in online courses. Push technologies are used by only two departments. Push technology uses individual student profile characteristics to automatically select course components (text, media, activities, etc.) from a database (content repository). This personalized content is then compiled (formatted or packaged) and delivered – "pushed" – to the student. Selection criteria can be as diverse and past learning, geographical location, proven competency, chosen delivery method, industry specifications, or a variety of learner requests.
- Most partners who responded to the survey use telephone-based audio conferencing as a course delivery tool. None use IP/based audio conferencing.
- Animation is the only type of multimedia presentation currently in use by partners in online course delivery.

Partner experience

- Most partner institutions have some experience developing online courses.

Resources available for development

- Design and development resources for the production of online courses are commonly available.
- Resources most frequently available include a/v production facilities, instructional design support, technical support and training, authoring tools and technologies, multimedia production facilities and funding for development. In some cases the resources available are limited in quantity or access.

Resources available for instructors

- In most cases, instructional design training, technical support and training to use online course tools are available for instructors. This is not universally the case, however.
- Administrative strategies to support online learning are not in place at all partner institutions.

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The purpose of this survey to give you the opportunity to assess the current and desired state of online learning at your institution. This information will help us develop the best practices for online learning methodologies, and it will help you get a better grasp of the technology available when you start developing your module.

Please complete the survey and send to Mary Wilson at the Learning Resources Unit, BCIT, 3700 Willingdon Avenue, Burnaby, BC, V5G 3H2. The survey can also be emailed to Mary_Wilson@bcit.ca or faxed to 604-431-7267

Name of institution: ______________________ Your name: ______________

1. Does your institution currently offer online courses? **Yes – 6 responses**

2. If yes, how many?
   Fewer than 100: 2
   100 – 1000: 2
   1000+: 1

3. Does your institution currently offer online health informatics courses?
   Yes: 2
   No: 3

4. What is (are) the platform(s) used to deliver online courses? (e.g. WebCT, Blackboard, web pages)
   WebCT: 4
   Web pages................................ 5
   CD-Rom with Web 1
   Blackboard 1
   Centra 1
   Wimba 1

5. Which statement best describes your institution's level of experience with online course development?

We're experts. (Whole programs & curriculums developed & offered.)	We have some experience. (Some courses developed & offered.)	We're just starting out. (In the process of developing & offering one or two courses.)	We have no experience.
1 response	**3 responses**	**1 response**	**1 response**

6. If you currently offer online courses, what type of courses are they? (Check all that apply.)

Undergrad	**5**	Degree	**2**	Diploma	**2**
Post certificate	**4**	Graduate	**3**	Continuing education	**4**

7. What design and development resources do you have available for online courses? (Check all that apply.)

Audio/Video production facilities	**4**	Instructional design support	**4**
Authoring tools and technologies	**5**	Technical support	**5**
Multimedia production facilities	**5**	Technical training	**5**
Educational technology strategy	**5**	Funding for development	**5**

Other resources (please list):

- **Dedicated offices/departments**
- **Evaluation of innovative instruction**
- **In some cases resources are present, but limited**

8. What resources do you have available for instructors delivering courses online? (Check all that apply.)

Instructional design training	**4**
Technical support	**5**
Technical training to use tools as an instructor	**4**

Other (please list):

9. What types of tools are available at your institution for flexible delivery? Are they used in your program area?

	Is this tool available at your institution?		Is this tool used in your program area?	
	Yes	No	Yes	No
Delivery Tools				
CD-ROM (integrated with delivery platform)	5		2	3
CD-ROM (stand alone)	5		3	2
Fax	4	1	3	2
Learning resource databases or literature management systems (e.g., ProQuest, ABI/Inform online, ProCite)	5		5	
Library/References	5		5	
Online content	5		4	1
Printed materials	5		5	
Course Tools				
Annotation	4	1	1	4
Application sharing	3	2	1	4
Assignments	5		4	1

	Is this tool available at your institution?		Is this tool used in your program area?	
	Yes	**No**	**Yes**	**No**
Compilation of content pages (e.g., compile tool or printable pdf)	**4**	**1**	**2**	**3**
Exams/Quizzes	**5**		**3**	**2**
File transfer/Drop box/Shared directory	**5**		**3**	**2**
Online marks	**5**		**2**	**3**
Polling	**4**	**1**		**5**
Selective release (e.g., tools, content, or exams)	**5**		**3**	**2**
Self tests	**4**	**1**	**2**	**3**
Survey	**4**		**2**	**3**
Search	**5**		**3**	**2**
Whiteboard (asynchronous or synchronous)	**3**	**2**		**5**
Communication Tools				
Audio conferencing (IP-based/Synchronous)	**2**	**2**		**5**
Audio conferencing (telephone-based)	**5**		**4**	
Chat (synchronous)	**5**		**2**	**3**
Email	**5**		**5**	
List serves	**4**	**1**	**3**	**2**
Text discussion (e.g. bulletin boards or forums)	**5**		**5**	
Video conferencing (IP-based)	**2**	**3**		**4**
Video conferencing (other)	**4**	**1**	**2**	**4**
Voicemail (IP-audio or telephone-based)	**5**		**5**	
Multimedia tools				
Audio presentation (streaming or audio clip)	**5**		**1**	**6**
Animation (e.g., Flash or Shockwave)	**5**		**3**	**3**
Simulations (e.g., VR environment, MUDS, MOOS, interactive)	**1**	**3**	**1**	**5**
Video presentation (streaming or video clip–e.g., QuickTime)	**4**	**1**	**1**	**4**

10. What types of design strategies are used at your institution for flexible delivery? Are they used in your program area?

	Used in institution?		Used in program?	
	Yes	**No**	**Yes**	**No**
Learning objects and repositories (self-describing packets of information that are tagged and searchable)	**1**	**4**	**1**	**5**
Library/References	**5**		**6**	
Mobile computing (e.g., PDAs or laptops)	**3**	**2**	**1**	**5**
Profiling	**1**	**3**		**5**
Push technologies	**1**	**2**	**2**	**4**
Wireless communication	**2**	**3**		**6**

Other strategies (please list)

11. Does your institution have an administrative strategy to support online learning?

    Yes 2

    No 2

    In development 1

12. Does your institution have a technical infrastructure to support online learning?

    Yes 5

    In some cases this is limited

13. What learning methodologies are you currently using in health informatics courses (e.g., case studies, group work, problem-based learning, work-based projects)?

    Problem-based learning.......... 2

    Critical appraisal...................... 1

    Practicum 1

    Case studies............................. 1

    Lecture...................................... 1

    Self-study modules 1

    Group work............................... 1

    Demonstration projects 1