Learning Theories and Transfer of Learning

Introduction

The intent of this Website is to help support the work of IT in education materials and users of such materials. Materials developers can incorporate ideas from a variety of learning theories into their materials. Teachers can incorporate ideas from this Website into their lesson plans and day to day teaching.

There are many additional different learning theories related to use of IT in education include:

- Anchored Instruction (John Bransford). This is closely related to Situated Learning.
- Cognitive Flexibility Theory (R. Spiro, P. Feltovitch & R. Coulson). This theory has a special emphasis on dealing with complex problem-solving situations (higher-order thinking skills).
- Experiential Learning (Carl Rogers)
- Multiple Intelligences (Howard Gardner)

Funderstanding: About Learning [Online]. Accessed 2/15/02: http://www.funderstanding.com/about_learning.cfm.

Funderstanding: About Learning. Accessed 2/15/02: http://www.funderstanding.com/about_learning.cfm. contains short discussion of 12 learning theories:

- Constructivism
- Behaviorism
- Piaget's Developmental Theory
- Neuroscience
- Brain-Based Learning
- Learning Styles
- Multiple Intelligences
- Right Brain/Left Brain
- Thinking
- Communities of Practice
- Control Theory
- Observational Learning
- Vygotsky and Social Cognition

Constructivism

The following definition is quoted from the Website: http://curriculum.calstatela.edu/faculty/psparks/theorists/501const.htm.

Constructivist learning is based on students' active participation in problem-solving and critical thinking regarding a learning activity which they find relevant and engaging. They are

"constructing" their own knowledge by testing ideas and approaches based on their prior knowledge and experience, applying these to a new situation, and integrating the new knowledge gained with pre-existing intellectual constructs.

The following definition is quoted from: Asynchronous Learning Networks Magazine Volume 1, Issue 1 - March 1997 ISSN 1092-7131. The Asynchronous Learning Networks Magazine (ALN Magazine) is published online by Vanderbilt University for the ALN Web. Responsibility for the contents rests upon the authors and not upon Vanderbilt University. Accessed 2/14/02: http://www.aln.org/alnweb/magazine/maga_issue1.htm.

Definition: Constructivism is an educational philosophy which holds that learners ultimately construct their own knowledge that then resides within them, so that each person's knowledge is as unique as they are. Among its key precepts are:

- situated or anchored learning, which presumes that most learning is context-dependent, so that cognitive experiences situated in authentic activities such as project-based learning;
- cognitive apprenticeships, or case-based learning environments result in richer and more meaningful learning experiences;
- social negotiation of knowledge, a process by which learners form and test their constructs in a dialogue with other individuals and with the larger society [15]. collaboration as a principal focus of learning activities so that negotiation and testing of knowledge can occur.

Constructivist philosophy is often contrasted with 'objectivist' philosophy and practice as embodied by instructional designers, especially ISD (Instructional Systems Design) practitioners, many of whom see constructivism either as nothing new or as not truly related to instruction [16], [17].

Relevance: Constructivism is one of the hot topics in educational philosophy right now. It potentially has profound implications for how current `traditional' instruction is structured, since it fits with several highly touted educational trends, for example:

- the transition of the teacher's role from "sage on the stage" (fount/transmitter of knowledge) to "guide on the side" (facilitator, coach);
- teaching "higher order" skills such as problem-solving, reasoning, and reflection (for example, see also generative learning);
- enabling learners to learn how to learn;
- more open-ended evaluation of learning outcomes;
- and, of course, cooperative and collaborative learning skills.

Relationship to ALN: ALNs can effectively support constructivism because of their emphasis on access to resources (which learners can use for knowledge construction) and to the extent that collaboration is used as a means of community formation (in which learners can also build

knowledge and test it through social negotiation). ALNs are not inherently constructivist; whether or not an ALN is constructivist depends on how the course is designed.

References on Constructivism

College of Education, University of Denver, Constructivism Site [Online]. Accessed 2/14/02: http://carbon.cudenver.edu/~mryder/itc_data/constructivism.html.

This Website contains many links to websites that, in total, provide a substantial introduction to the field of constructivism.

Links Dealing with Constructivism … [Online]. Accessed 5/11/01: http://members.it.tripod.de/~Knowing/Costructivism-links.htm.

Contains a number of links to online resources (mainly published papers) dealing with constructivism.

Piaget's Developmental Theory: Cognitive Constructivism [Onine]. Accessed 2/26/02: http://pdts.uh.edu/~srmehall/theory/cognitive.html. Quoting from the Website:

Jean Piaget is a Swiss psychologist who began to study human development in the 1920s. His proposed a development theory has been widely discussed in both psychology and education fields. To learn, Piaget stressed the holistic approach. A child constructs understanding through many channels: reading, listening, exploring and experiencing his or her environment.

Piaget's Stages of Cognitive Development

Approximate Age	Stage	Major Developments
Birth to 2 years	Sensorimotor	Infants use sensory and motor capabilities to explore and gain understanding of their environments.
2 to 7 years	Preoperational	Children begin to use symbols. They respond to objects and events according to how they appear to be.
7 to 11 years	Concrete operations	Children begin to think logically.
11 years and beyond	Formal operations	They begin to think about thinking. Thought is systematic and abstract.

A child will develop through each of these stages until he or she can reason logically. The learner is advanced through three mechanisms.

1. Assimilation - fitting a new experience into an existing mental structure (schema)

2. Accommodation - revising an existing schema because of a new experience
3. Equilibrium - seeking cognitive stability through assimilation and accommodation

President's Committee of Advisors on Science and Technology: Panel on Educational Technology [Online] (1997). Accessed 5/17/01: hhttp://www.ostp.gov/PCAST/k-12ed.html.

This report contains an excellent introduction to constructivism, with a focus on constructivism in an IT environment. Quoting from the book:

In recent years, however, many researchers have begun to focus on the potential of technology to support certain fundamental changes in the pedagogic models underlying our traditional approach to the educational enterprise. Within this "constructivist" paradigm:

- Greater attention is given to the acquisition of higher-order thinking and problem-solving skills, with less emphasis on the assimilation of a large body of isolated facts.
- Basic skills are learned not in isolation, but in the course of undertaking (often on a collaborative basis) higher-level "real-world" tasks whose execution requires the integration of a number of such skills.
- Information resources are made available to be accessed by the student at that point in time when they actually become useful in executing the particular task at hand.
- Fewer topics may be covered than is the case within the typical traditional curriculum, but these topics are often explored in greater depth.
- The student assumes a central role as the active architect of his or her own knowledge and skills, rather than passively absorbing information proffered by the teacher.

Some of the specific ways in which technology might be used within the context of the constructivist curriculum are outlined in Section 4.

Situated Learning

The main focus in the Computer-using Educators section of the OTEC Website is on the appropriate integration of IT into curriculum, instruction, and assessment. If this integration is done properly, the whole will be greater than the sum of the parts. That is, students can be learning both IT and a specific non-IT discipline such as language arts or science simultaneously. This occurs, for example, when students are doing Project-Based Learning and are using IT as both a research aid and as a presentation aid.

Over the past 20 years or so, a learning theory called Situated Learning has been developed. Some references that help to define this theory are given below. The focus is on learning by doing, and on addressing real problems. IT is a powerful aid to "doing" and to "addressing real problems." Thus, Situated Learning and IT work well together. Situated Learning and Constructivism are compatible and appear to be mutually supportive.

The following discussion is from a page on a Website maintained by Greg Kearsley. Accessed 2/14/02: http://tip.psychology.org/lave.html.

[Jean] Lave argues that learning as it normally occurs is a function of the activity, context and culture in which it occurs (i.e., it is situated). This contrasts with most classroom learning activities which involve knowledge which is abstract and out of context. Social interaction is a critical component of situated learning -- learners become involved in a "community of practice" which embodies certain beliefs and behaviors to be acquired. As the beginner or newcomer moves from the periphery of this community to its center, they become more active and engaged within the culture and hence assume the role of expert or oldtimer. Furthermore, situated learning is usually unintentional rather than deliberate. These ideas are what Lave & Wenger (1991) call the process of "legitimate peripheral participation."

Other researchers have further developed the theory of situated learning. Brown, Collins & Duguid (1989) emphasize the idea of cognitive apprenticeship: "Cognitive apprenticeship supports learning in a domain by enabling students to acquire, develop and use cognitive tools in authentic domain activity. Learning, both outside and inside school, advances through collaborative social interaction and the social construction of knowledge." Brown et al. also emphasize the need for a new epistemology for learning -- one that emphasizes active perception over concepts and representation. Suchman (1988) explores the situated learning framework in the context of artificial intelligence.

References on Situated Learning

Brown, John Seely , et al. (1989). Situated Cognition and the Culture of Learning [Online]. Accessed 12/4/00: http://www.slofi.com/situated.htm. When this address was checked 4/15/02 it no longer worked. The address http://www.slofi.com/ is the Homepage for a recent (April, 2002) book by John Seely Brown and Paul Duguid.

Quoting the abstract of the originally cited article:
Many teaching practices implicitly assume that conceptual knowledge can be abstracted from the situations in which it is learned and used. This article argues that this assumption inevitably limits the effectiveness of such practices. Drawing on recent research into cognition as it is manifest in everyday activity, the authors argue that knowledge is situated, being in part a product of the activity, context, and culture in which it is developed and used. They discuss how this view of knowledge affects our understanding of learning, and they note that conventional schooling too often ignores the influence of school culture on what is learned in school. As an alternative to conventional practices, they propose cognitive apprenticeship (Collins, Brown, & Newman, in press), which honors the situated nature of knowledge. They examine two examples of mathematics instruction that exhibit certain key features of this approach to teaching.

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In the creation of classroom tasks, apparently peripheral features of authentic tasks--like the extralinguistic supports involved in the interpretation of communication--are often dismissed as "noise" from which salient features can be abstracted for the purpose of teaching. But the context

of activity is an extraordinarily complex network from which practitioners draw essential support. The source of such support is often only tacitly recognized by practitioners, or even by teachers or designers of simulations. Classroom tasks, therefore, can completely fail to provide the contextual features that allow authentic activity. At the same time, students may come to rely, in important but little noticed ways, on features of the classroom context, in which the task is now embedded, that are wholly absent from and alien to authentic activity. Thus, much of what is learned in school may apply only to the ersatz activity, if it was learned through such activity.

Jasper Overview: What is the Jasper Series? [Online]. Accessed 12/4/00: http://peabody.vanderbilt.edu/ctrs/ltc/Research/jasper_overview.html. Quoting from the Website:

The Adventures of Jasper Woodbury consists of 12 videodisc-based adventures (plus video based analogs, extensions and teaching tips) that focus on mathematical problem finding and problem solving. Each adventure is designed from the perspective of the standards recommended by the National Council of Teachers of Mathematics (NCTM). In particular, each adventure provides multiple opportunities for problem solving, reasoning, communication and making connections to other areas such as science, social studies, literature and history (NCTM, 1989; 1991).

Jasper adventures are designed for students in grades 5 and up. Each videodisc contains a short (approximately 17 minute) video adventure that ends in a complex challenge. The adventures are designed like good detective novels where all the data necessary to solve the adventure (plus additional data that are not relevant to the solution) are embedded in the story. Jasper adventures also contain "embedded teaching" episodes that provide models of particular approaches to solving problems. These episodes can be revisited on a "just-in-time" basis as students need them to solve the Jasper challenges.

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The developers of the Jasper series have observed, as have other researchers in education and psychology, that classroom learning is very different from "natural" learning environments. Natural learning environments, like those in which parents help their children develop language, are often characterized as "contextualized." Participants, in this case the parent and the child, share a context, or a common frame of reference, in which the learning takes place. Additionally, in natural learning environments, the tasks the teacher asks the learner to perform are authentic. They arise naturally in the context, and the participants care about the outcomes. Finally, the knowledge that is being learned is often viewed as a tool to accomplish the tasks, and the learner sees it as valuable knowledge that can be used in new situations.

Roschelle, Jeremy. What Should Collaborative Technology Be? A Perspective from Dewey and Situated Learning [Online]. Accessed 11/28/00: http://www-cscl95.indiana.edu/cscl95/outlook/39_roschelle.html Quoting from the Website:

Situated learning (Greeno, 1989; Brown, Collins, & Duguid, 1989) is a stance holding that inquiries into learning and cognition must take serious account of social interaction and physical activity. A unifying concept emerging from situated learning research is "communities of practice"--the idea that learning is constituted through the sharing of purposeful, patterned activity (Lave & Wenger, 1989). This idea stresses "practice" and "community" equally. Knowledge is seen as practical capability for doing and making. Meaning is seen as a construction of a social unit that shares a stake in a common situation. As a consequence, learning is seen as a capability for increased participation in communally experienced situations--a dual affair of constructing identity and constructing understanding (Wenger, 1990).

Constructs from situated learning research and John Dewey's philosophy support a distinction between technological settings for collaboration and truly collaborative technologies. The key difference is the use of technology in the construction of shared resolutions to problematic experience. This requires the public use of the technology in a shared perceptual space where it can become an instrument of mutual knowledge construction for a group of people. It is through the skillful deployment of collaborative technologies that communities of practice can grow and learn.

Situated Learning in Adult Education. ERIC Digest No. 195 [Online]. Accessed 11/28/00: http://www.ed.gov/databases/ERIC_Digests/ed418250.html.Quoting from the ERIC Digest::

In the situated learning approach, knowledge and skills are learned in the contexts that reflect how knowledge is obtained and applied in everyday situations. Situated cognition theory conceives of learning as a sociocultural phenomenon rather than the action of an individual acquiring general information from a decontextualized body of knowledge.

Transfer of Learning

Teaching for transfer is one of the seldom-specified but most important goals in education. We want students to gain knowledge and skills that they can use both in school and outside of school, immediately and in the future.

Transfer of learning deals with transferring one's knowledge and skills from one problem-solving situation to another. You need to know about transfer of learning in order to help increase the transfer of learning that you and your students achieve.

Transfer of learning is commonplace and often done without conscious thought. For example, suppose that when you were a child and learning to tie your shoes, all of your shoes had brown, cotton shoelaces. You mastered tying brown, cotton shoelaces. Then you got new shoes. The new shoes were a little bigger, and they had white, nylon shoe laces. The chances are that you had no trouble in transferring your shoe-tying skills to the new larger shoes with the different shoelaces.

This example gives us some insight into one type of transfer of learning. Transfer occurs at a subconscious level if one has achieved automaticity of that which is to be transferred, and if one

is transferring this learning to a problem that is sufficiently similar to the original situation so that differences are handled at a subconscious level, perhaps aided by a little conscious thought.

However, there are many transfer of learning situations that are far more difficult than shoe tying. For example, a secondary school math class might teach the metric system of units. From the math class, students go to a science class. Frequently the science teacher reports that the students claim a complete lack of knowledge about the metric system. Essentially no transfer of learning has occurred from the math class to the science class.

On a more general note, employers often complain that their newly hired employees have totally inadequate educations. Part of their complaint is that the employees cannot perform tasks on the job that they "should have" learned to do while in school. Schools respond by saying that the students have been taught to accomplish the tasks. Clearly, this is a transfer of learning problem that is owned jointly by schools, employees, and employers.

The goal of gaining general skills in the transfer of your learning is easier said than done. Researchers have worked to develop a general theory of transfer of learning--a theory that could help students get better at transfer. This has proven to be a difficult research challenge.

At one time, it was common to talk about transfer of learning in terms of near and far transfer. This "near and far" theory of transfer suggested that some problems and tasks are so nearly alike that transfer of learning occurs easily and naturally. A particular problem or task is studied and practiced to a high level of automaticity. When a nearly similar problem or task is encountered, it is automatically solved with little or no conscious thought. This is called near transfer. The shoe-tying example given above illustrates near transfer. A major goal in learning to read is to develop a high level of decoding automaticity. Then your conscious mind can pay attention to the meaning and implications of the material you are reading. A significant fraction of children are able to achieve this by the end of the third grade.

Many potential transfer of learning situations do not lend themselves to the automaticity approach. There are many problems that are somewhat related, but that in some sense are relatively far removed from each other. A person attempting to make the transfer of learning between two such problems does not automatically "see" or sense the connections between the two problems. Far transfer often requires careful analysis and deep thinking.

The theory of near and far transfer does not help us much in our teaching. We know that near and far transfer occur. We know that some students readily accomplish far transfer tasks, while others do not. We know that far transfer does not readily occur for most students. The difficulty with this theory of near and far transfer is that it does not provide a foundation or a plan for helping a person to get better at far transfer and dealing with novel and complex problems. It does not tell us how to teach to increase far transfer.

In recent years, the low-road/high-road theory on transfer of learning, developed by Salomon & Perkins (1988), has proven to be a more fruitful theory. Low-road transfer refers to developing some knowledge/skill to a high level of automaticity. It usually requires a great deal of practice

in varying settings. Shoe tying, keyboarding, steering a car, and single-digit arithmetic facts are examples of areas in which such automaticity can be achieved and is quite useful.

High-road transfer involves: cognitive understanding; purposeful and conscious analysis; mindfulness; and application of strategies that cut across disciplines. In high-road transfer, there is deliberate mindful abstraction of an idea that can transfer, and then conscious and deliberate application of the idea when faced by a problem where the idea may be useful.

References on Transfer of Learning

Perkins, David N. and Salomon, Gavriel (September 2, 1992). Transfer of Learning: Contribution to the International Encyclopedia of Education, Second Edition Oxford, England: Pergamon Press. [Online]. Accessed 2/27/02: http://learnweb.harvard.edu/alps/thinking/docs/traencyn.htm. Quoting from the Website:

High road and low road transfer. Salomon and Perkins (1989, Perkins and Salomon 1987) synthesized findings concerned with transfer by recognizing two distinct but related mechanisms, the ``low road'' and the ``high road.'' Low road transfer happens when stimulus conditions in the transfer context are sufficiently similar to those in a prior context of learning to trigger well-developed semi-automatic responses. In keeping with the view of Greeno et al. (in press), these responses need not be mediated by external or mental representations. A relatively reflexive process, low road transfer figures most often in near transfer. For example, when a person moving a household rents a small truck for the first time, the person finds that the familiar steering wheel, shift, and other features evoke useful car-driving responses. Driving the truck is almost automatic, although in small ways a different task.

High road transfer, in contrast, depends on mindful abstraction from the context of learning or application and a deliberate search for connections: What is the general pattern? What is needed? What principles might apply? What is known that might help? Such transfer is not in general reflexive. It demands time for exploration and the investment of mental effort. It can easily accomplish far transfer, bridging between contexts as remote as arteries and electrical networks or strategies of chess play and politics. For instance, a person new to politics but familiar with chess might carry over the chess principle of control of the center, pondering what it would mean to control the political center.

Salomon, G., & Perkins, D. (1988, September). Teaching for transfer. Educational Leadership, 22-32.

Salomon and Perkins have developed the high-road/low-road theory of transfer of learning. The article listed here provides a good overview of the domain of transfer of learning and how to teach transfer. It also contains an extensive bibliography, so it is a good starting point if you want to study the research on transfer of learning.

Transfer of Learning: Planning Workplace Education Programs [Online]. Accessed 4/8/01: http://www.nald.ca/nls/inpub/transfer/English/page01.htm. Quoting from the Website:

Transfer of learning is pervasive in our everyday life at work, at home and in the community. Transfer takes place whenever our existing knowledge, abilities and skills affect the learning or performance of new tasks. But what are the principles of effective transfer of learning? How can workplace instructors design training programs to facilitate transfer? What can the shop floor supervisor do to encourage transfer of learning? How should trainees or participants prepare for transfer back on the job? Given the centrality of this topic to so many areas of workplace education, this discussion paper will draw together the results of research and some practical techniques that will help practitioners in the field. It Is organized into four parts: 1) definitions of learning transfer, 2) factors influencing the transfer of learning, 3) integrating learning transfer into program planning and 4) strategies to enhance the transfer of learning. The report is summarized through a number of application exercises that challenges the reader to recall former workplace education experiences and interact with contents of the document.

General Learning Theory References

Adult Multiple Intelligences [Online]. Accessed 2/27/01: http://pzweb.harvard.edu/ami/.

This reflects work at Harvard, including Project Zero, that extended over several years.

Bloom, Benjamin [Online]. Accessed 2/24/02: http://www.bena.com/ewinters/Bloom.html.

Benjamin Bloom is probably best known for his 1956 "taxonomy." However, he also did seminal work on student learning through different methods such as tutoring, peer tutoring, mastery learning, and so on. The following taxonomy is quoted from the Website:

Knowledge: Observe and recall information knowledge of dates, events, places

- know major ideas
- mastery of basic subject matter

verbs:

- list, define, tell, describe, identify, show, label, collect, examine,
- tabulate, quote, name, who, when, where

Comprehension

- understand information grasp meaning translate knowledge to a
- new context interpret facts, compare, contrast order, group, infer
- causes predict consequences

verbs:

- summarize, describe, interpret, contrast, predict, associate,
- distinguish, estimate, differentiate, discuss, extend

Application

- use information, use methods, concepts, theories in new
- situations solve problems; use required skills or knowledge

verbs:

- apply, demonstrate, calculate, complete, illustrate, show, solve,
- examine, modify, relate, change, classify, experiment, discover

Analysis

- see patterns, organize the parts, recognize hidden meanings,
- identify components

verbs:

- analyze, separate, order, explain, connect, classify, arrange,
- divide, compare, select, explain, infer

Synthesis

- use old ideas to create new ones
- generalize from given facts relate knowledge from several areas
- predict, draw conclusions

verbs:

- combine, integrate, modify, rearrange,
- substitute, plan, create, design, invent,
- what is it?, compose, formulate, prepare,
- generalize, rewrite

Evaluation

- compare/discriminate between ideas,
- assess value of theories, make choices based on argument, verify
- value of evidence,
- recognize subjectivity

verbs:

- assess, decide, rank, grade, test, measure, recommend, convince,
- select, judge, explain, discriminate, support,
- conclude, compare

Cooperative Learning Center at University of Minnesota [Online]. Accessed 1/24/02: http://www.clcrc.com/. Quoting from the Website:

What is Cooperative Learning?

Cooperative Learning is a relationship in a group of students that requires positive interdependence (a sense of sink or swim together), individual accountability (each of us has to contribute and learn), interpersonal skills (communication, trust, leadership, decision making, and conflict resolution), face-to-face promotive interaction, and processing (reflecting on how well the team is functioning and how to function even better).

What does the Cooperative Learning Center do?

The Cooperative Learning Center is a Research and Training Center focusing on how students should interact with each other as they learn and the skills needed to interact effectively.

Explorations in Learning & Instruction: The Theory Into Practice Database [Online]. Accessed 10/18/01: http://tip.psychology.org/index.html.

A brief introduction to 50 different learning theories.

Ip, Alex. Transfer of Learning [Online]. Accessed 2/27/02: http://www.cdtl.nus.edu.sg/ideas/iot18.htm.

Alex Ip is Assistant Director for the Centre for Development of Teaching and Learning. Quoting from this brief article:
The goal of all learning is to make information portable, so that learning travels with the learner to new locations. In the new locations, the learning is transferred and applied in novel, interesting, and innovative ways. This is the phenomenon referred to as the 'Transfer of Learning'. When transfer of learning occurs, it is in the form of meanings, expectations, generalisations, concepts, or insights that are developed in one learning situation being employed in others (Bigge and Shermis, 1992).

Basically, education that does not achieve considerable transfer is not worth much! In its broadest sense, transfer of learning is basic to the whole notion of schooling. If there is no transfer at all, students will need to be taught specifically every act that they will ever perform in any situation (Bigge and Shermis, 1992). However, we often over-emphasise the transmission of information (by the teacher) and the retention of information (by the student) in our own disciplines that we overlook this very important aspect of learning.

A person is in the best frame of mind for transfer to occur when he/she is aware of acquiring meanings and abilities that are widely applicable in learning and living. He/she must also want to solve new problems, or approach new situations and take risks, in the light of the insights gained through previous experience. For transfer to occur, individuals must generalize (i.e. perceive common factors in different situations, comprehend the factors as applicable and appropriate to both situations and thereby understand how a generalization can be used); and they must desire

to benefit by the sensed commonality (Bigge and Shermis, 1992). Teachers can act as guides and prompters to "shepherd" knowledge and skills from one context to another (Forgarty et al, 1991).

Learning Theories [Online]. Accessed 11/28/00:
http://www.educationau.edu.au/archives/cp/04.htm

A brief introduction to 13 different learning theories.

Retrieved from- http://otec.uoregon.edu/learning_theory.htm#transfer