

Learning Theories proliferating Use of Computers

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Abstract

The potential of computers for enhancing teaching-learning process has received considerable attention in recent times. The present paper attempts to study in detail various learning theories of educational psychology that lay foundation for incorporation of computers by the teachers in teaching learning process. This study is concerned with those theories of learning that have had the greatest effect in the past on learning with the aid of a computer, as well as with those theories which appear to hold the promise for future use in computer-based instructions.

Keywords: learning; learning theory

1. INTRODUCTION

Thinking about the computer's role in education does not mean thinking about computers, it means thinking about education.

Alan Ellis, 'The Use and Misuse of Computers in Education', 1974

The potential of computer technology to enhance teaching and learning has been recognized for some time. There is certainly evidence worldwide (Pelgrum & Plomp, 1991) describing the phenomenal infusion of computers in teaching-learning process. Generally, it is accepted that technology has the potential to enhance teaching and learning and provides students with a learning experience that other strategies cannot provide (Wellington, 2005). Schools have also recognized that the use of computers in teaching-learning process is important as it presents with unprecedented challenges that helps students to acquire an inquiring, critical and creative mind to capitalize on the opportunities driven by the explosive growth of information, knowledge and technology (Cuban, 2001). Links have been made between computer use and constructivist, collaborative, and inquiry-based learning and also to pedagogical change (Scrimshaw, 2004). Computer technology has opened wide opportunities for teachers to integrate computers in teaching-learning process and to improve the achievement of students (Jonassen, 1995). The use of computers in teaching-learning process inspires the teachers to approach their tasks with a greater sense of

purpose and, more importantly, a sense of effectiveness to make students active, curious, interested, self-learners .

2. LEARNING PROCESS

Learning is defined as relatively permanent change in the student's behaviour. Learning is the development of new knowledge, skills, or attitudes, when the individual interacts with information and environment. Learning takes place all the time. Learning may be incidental, but this study is primarily concerned with the learning that takes place in response to teachers' instructional efforts. The teaching-learning process involves the selection, arrangement, and delivery of information in an appropriate environment and how the learner interacts with that information. How teachers design and arrange instruction has a great deal to do not only with what is learned but also with how the learner uses what is learnt. Learning is a process that progresses from an initial level of poor knowledge and performance to levels of increased knowledge and much better performance, when and only when a teacher supports a student's progress.

3. LEARNING THEORIES

In psychology and education, a common definition of learning is a process that brings together cognitive, emotional, environmental influences and experiences for acquiring, enhancing, or making changes in one's knowledge, skills, values, and world views (Ormorod, 1995; Illeris, 2000). Learning as a process focuses on what happens when the learning takes place. Explanations of what happens constitute learning theories. A learning theory is an attempt to describe how people learn; thereby helps in understanding the inherently complex process of learning.

Since a major purpose for use of computers by school teachers is to affect students' behavior that serve objectives, it is appropriate to turn to the psychology of learning for help in locating principles that would guide the effective use of computers by teachers in teaching-learning process. Learning theories form the bases for technology integration models. Since learning occurs in numerous ways, there are also various learning theories. There have been several classes of theories with regard to learning which formed the

basis for use of computers in education. The underlying principle, in the earlier attempts at use of computers in teaching-learning process in the development of computer assisted instructional lessons, can be traced to one of the two prominent class of theories, i.e., behaviorism, and cognitivism. As behaviorism focuses only on the objectively observable aspects of learning; cognitive theories look beyond behavior to explain brain-based learning. Recent evolution in the field has been the development of constructivism, that views learning as a process in which the learner actively constructs or builds new ideas or concepts, a theory specially related to intelligent tutorial systems and expert systems.

However, as technology has become more capable and complex, views of education and appropriate teaching strategies have been changed. Hirsch (2002) points out that there are two different views on teaching and learning. One view, Directed or Objectivist Instruction, is grounded primarily in behaviourist learning theory and the information-processing branch of the cognitive learning theories. The other view, which Roblyer (2003) refers to as Constructivist or Inquiry-Based Learning, evolved from other branches of thinking in cognitive learning theory. Objectivists believe that knowledge has a separate, real existence of its own outside the human mind and learning happens when this knowledge is transmitted to people and they store it in their minds. Constructivists on the other hand think that humans construct all knowledge in their minds by participating in certain experiences and learning occurs when one constructs both mechanisms for learning and his or her own unique version of the knowledge, colored by background, experiences, and aptitudes. A few technology applications such as drill and practice and tutorials are associated only with directed instruction; most others (problem solving, multimedia production, web-based learning) can enhance either directed instruction or constructivist learning, depending on how they are used. Use of such theories is restricted not only to 'development and application of' but they are also applied in the studies on extent of computer use, effectiveness and impact of computer use on educational interactions.

This study is concerned with those theories of learning that have had the greatest effect in the past on learning with the aid of a computer, as well as with those theories which appear to hold the promise for future use in computer-based instructions. A brief description of each class of theory is presented below.

3.1 Objectivist Learning Theories

- (i) **Behaviourist-Connectionist Theories:** These are based on the principle that instruction should be designed to produce observable and quantifiable behavioural changes among the learners. Use of behavioural objectives advocated by behaviourists is well accepted in the educational circles. Behaviourism was used as a basis for designing computer based instructions and it was also responsible for many related teaching strategies such as teaching machines and programmed texts (Simpson and Thompson, 1991). Pavlov's classical conditioning and Skinner's operant conditioning were responsible for providing the much needed direction to early researchers who examined the impact of computer based instructions on behaviour.
- **Classical Conditioning Theory** by Ivan Pavlov (1903): This theory is a form of associative learning that involves presentations of a neutral stimulus or conditioned stimulus (CS) along with a stimulus of some significance. Conversely, presentation of the significant stimulus or unconditioned stimulus (US) necessarily evokes an innate, often reflexive, response or unconditioned response (UR). If the CS and the US are repeatedly paired, eventually the two stimuli become associated and the organism begins to produce a behavioral response or conditioned response (CR) to the CS. An important computer-based educational consequence of Pavlov's work was the promotion of the idea of organising the lesson from 'very simple to very complex events' and leading the research on the ways to use stimuli to produce desirable behaviours.
- **Connectionism Theory** by Edward Thorndike (1898): Learning is the formation of a connection between stimulus and response. The basis of learning is a series of connections and what has been accomplished already. Thorndike's view of learning as habit formation rests on connecting more habits into a complex structure and 'teaching' as enhancing desirable connections or bonds. He developed three laws, viewed as his major contribution towards learning: Law of Effect - responses to a situation which are followed by a rewarding state of affairs will be strengthened and become habitual responses to that situation, Law of Readiness - a series of responses can be chained together to satisfy some goal which will result in annoyance if blocked, and Law of Exercise - connections

become strengthened with practice and weakened when practice is discontinued. Thorndike's connectionism is credited for the development of the 'influence of conditions of learning on behaviour', 'change of attitude and abilities of learner over a time through stimuli', 'design and control instructional experiences' and 'appropriate stimuli selection and integration for reinforcements' (Orstein and Hunkins, 1993).

- **Operant Conditioning Theory** by B.F. Skinner (1954): Skinner believed that learning is a behavioural change and people can learn more effectively if their environment is carefully controlled. He developed the principles of operant (behaviour) conditioning which basically stated that learning takes place as a result of reinforcement of the behavior by a reward or a punishment. The word 'operant' refers to the way in which behavior 'operates on the environment'. Briefly, a behavior may result either in reinforcement, which increases the likelihood of the behavior recurring, or punishment, which decreases the likelihood of the behavior recurring. Skinner introduced the concepts of primary, secondary, positive and negative reinforcements. Educational approaches such as applied behavior analysis, curriculum based measurement, and direct instructions have emerged from this model. Skinner's contributions include the following pertinent techniques for educational practices and for CAI: statement of objectives in terms of intended terminal behaviour; assessment of previous knowledge before instruction; placing learner in sequence of instruction where one can achieve the 90% level; using teaching machines to reinforce and strengthen the desired terminal behaviour; and recording learner's progress to gain feedback for revision.

Skinner, among the three prominent behaviourists, was the most vocal advocate of behaviourism applied to teaching machines and specially computers. It has been responsible for promoting concepts such as design of desirable learning outcomes i.e., objectives-based instruction, pre-assessment of learners and mastery learning. It has also been responsible for providing cues on presentation of small chunk of information by computer lessons, positive reinforcement, feedback and multiple instructions to attain minimum competency level.

- (ii) **Information Processing Theory** by Richard Atkinson and Richard Shiffrin (1968): The brain contains three kinds of memory or 'stores', to process information – just like a computer. Sensory registers (Sensory Memory SM) receive information a person senses through receptors (i.e., eyes, ears, nose, mouth, hands). After a second or so, the information is either lost or transferred to short-term memory (STM) or working memory. STM holds new information for about 5 to 20 seconds. Unless it is processed or practiced in a way that causes it to transfer to long-term memory (LTM), it also is lost. LTM can hold information indefinitely, but for new information to be transferred to LTM, it must be linked in some way to prior knowledge already in LTM. Information processing involves: a) students are actively processing, storing and retrieving information b) teaching involves helping learners to develop information processing skills and apply them systematically to mastering the curriculum. Cognitive structures relate to structure of the subject matter. Information processing emphasizes cognitive structures built by the learner. Common teaching practices based on these concepts include the use of interesting questions and eye-catching material to help students pay attention to a new topic; instructions that point out important points in new material to help students remember them by linking them to information they already know; and practice exercises to help transfer information from STM to LTM.
- (iii) **Cognitive - Behavioural Theory** by Robert Gagne (1965): Gagne identified the mental conditions for learning. These were based on the information processing model of the mental events that occur when the individuals are presented with various stimuli. Gagne outlines the following nine instructional events and corresponding cognitive processes (Kearsley 1994a): gaining attention (reception), informing learners of the objective (expectancy), stimulating recall of prior learning (retrieval), presenting the stimulus (selective perception), providing learning guidance (semantic encoding), eliciting performance (responding), providing feedback (reinforcement), assessing performance (retrieval), enhancing retention and transfer (generalization). Gagné's theory stipulates that there are several different types or levels of learning (verbal information, intellectual skills, cognitive strategies, motor skills, attitudes) and that each specific type or level requires unique type

of instruction. Gagne also contends that learning tasks for intellectual skills can be organized in a hierarchy according to complexity: stimulus recognition, response generation, procedure following, use of terminology, discriminations, concept formation, rule application, problem solving. The primary significance of this hierarchy is to provide direction for instructors so that they can "identify prerequisites that should be completed to facilitate learning at each level" (Kearsley 1994a). Gagne's nine instructional events and corresponding cognitive processes can serve as the basis for designing instruction and selecting appropriate media (Gagne, Briggs and Wager, 1992). Gagne, Wager, and Rojas (1981) showed that Gagne's Events of Instruction could be used to plan lessons using each kind of instructional software (drill, tutorial, simulation, gaming, problem-solving). According to them, only a tutorial could "stand by itself" and accomplish all of the necessary Events of Instruction; the other kinds of software require teacher - led activities to accomplish events before and after software use.

- (iv) **Systems Theory and Systematic Instructional Design:** This theory was originally proposed by biologist Ludwig von Bertalanffy in 1928. The term system means 'a whole', a set of interconnected things or parts, an organized body of material, or any set of components that work together to achieve a specified outcome or goal. An important aspect of any system is the feedback mechanisms that ensure the goal is achieved or maintained. A system can be defined as 'an orderly arrangement or combination of interrelated and interdependent parts or elements emerging as a whole'. Development of the theory has been a result of increased acceptance of science and scientific methods as a systems approach. In educational settings, this theory is being applied by translating its principles into well defined procedures. Application of such procedures as product of an established theory is based on ideas like 'logical problem solving - scientific method', decision making, rationality and integration. In particular, this approach for design of instruction, especially CAI, prescribes a series of stages. This approach provides a step-by-step system for the evaluation of students' needs, the design and development of learning materials as learning intervention, and evaluation of the effectiveness of learning intervention. There are more than 100 different

instructional design models, but almost all are based on the generic "ADDIE" model, which stands for Analysis, Design, Development, Implementation, and Evaluation, as illustrated below. Each step has an outcome that feeds the subsequent step.

Analysis → Design → Development → Implementation → Evaluation

During analysis, the designer develops a clear understanding of the "gaps" between the desired outcomes or behaviors, and the audience's existing knowledge and skills. The design phase documents specific learning objectives, assessment instruments, exercises, and content. The actual creation of learning materials is completed in the development phase. During implementation, these materials are delivered or distributed to the student group. After delivery, the effectiveness of the training materials is evaluated. Combination of these step-by-step processes is known as Systems Approach to Instructional Design, Systematic Instructional Design, Instructional Systems Design (ISD), Instructional Systems Design & Development (ISDD), Systems Approach to Training (SAT), or just Instructional Design (ID). Instructional design is a tested and proven methodology for developing instruction. A well-known instructional design model is The Dick and Carey Systems Approach Model (1978): "Components such as the instructor, learners, materials, instructional activities, delivery system, and learning and performance environments interact with each other and work together to bring about the desired student learning outcomes". The steps of this model are: Identify Instructional Goal(s), Conduct Instructional Analysis, Analyze Learners and Contexts, Write Performance Objectives, Develop Assessment Instruments, Develop Instructional Strategy, Develop and Select Instructional Materials, Design and Conduct Formative Evaluation of Instruction, Revise Instruction Design and Conduct Summative Evaluation. Now-a-days, ID has become the standard for textbook authoring and development of computer-based learning materials. Systems approach to instructional design is well accepted and best known particularly for designing CAI (Anderson & Faust, 1973; Briggs, 1977; Roblyer, 1981). Since instructional design results in a highly structured sequence of instruction, computer tutorials and self-based distance learning courses offer ideal delivery systems for instruction design through these approaches. The development

process for CD-ROM or Web-based training programs use a modified ADDIE model, which borrows from the most valuable aspects of the systemic approach.

3.2 Constructivist Learning Theories

- (i) **Social Activism Theory** by John Dewey (1899): Dewey thought that learning is an individual growth that occurs through social experiences. Dewey deplored standardization and believed that curriculum should arise from students' interests. He believed that curriculum topics should be integrated, rather than isolated, since teaching isolated topics prevented learners from grasping the whole of knowledge. He believed that education should be a way of helping individuals understand their culture and develop their relationship to and unique roles in society. This theory also implies that individual growth is fostered through hands-on and experience-based activities relating to real-life issues. The educational implication includes curriculum based on student's interest, integrated topics, culture and society understanding, hands-on learning, meaningful learning stems from group work. Bruce (2000) says that Dewey would approve of technologies like the Internet to help students communicate with each other and learn about their society. Dewey's call for cooperative learning would mesh well with technology-based group projects and presentations. When using the social activism theory, teachers can use visual presentations on a computer to help students connect abstract concepts with real-life applications.
- (ii) **Scaffolding Theory** by Lev Vygotsky (1922/1978): Learning is a cognitive development process shaped by individual differences and influenced by the individual's social interaction. The theory describes social and instructional support for students learning new concepts, comparable to structures erected alongside newly constructed buildings. A child follows an adult's example and gradually develops the ability to do certain tasks without help or assistance. The scaffolding supports the construction (the introduction of new material) and is taken away after completion (or when the lesson is understood). Vygotsky proposed that learning depends on the zone of proximal development (ZPD), which he defined as the distance between the actual developmental level as determined by independent problem-solving and the level of potential development as determined

through problem-solving under adult or peer guidance. He believed that students must be taught information within their ZPD to develop a relationship with the material, then the scaffolding must be taken away to fully form an understanding. If a task seemed outside the student's abilities with and without the scaffolding, it was the teacher's responsibility to seek a challenging task still within the student's ZPD. Strength of this theory is that it gradually withdraws expert support, allowing the novice to grasp the concept. Ormrod (2001) says that teachers promote students' cognitive development by presenting tasks that "they can complete only with assistance, that is, within each student's Zone of Proximal Development" (p.59). Technology can help implicate scaffolding by the use of many graphic examples and visual tools, which can help students to better understand complex concepts.

- (iii) **Child Development Theory** by Jean Piaget (1950): Piaget believed that, all children go through four stages of cognitive development, that each stage occurs only after certain genetically controlled neurological changes, and that all children develop higher reasoning abilities in the same sequence. The four stages are: sensorimotor - birth to 2 years, the mental structures are mainly concerned with the mastery of concrete objects; preoperational - 2 to 7 years, the mastery of symbols takes place; concrete operational - 7 to 11 years, children learn mastery of classes, relations, and numbers and how to reason; and formal operational (abstract thinking) - 11 years and up, the mastery of thought. Each stage has major cognitive tasks which must be accomplished. The inherent assumption in Piaget's prescription is the concept of Maturation, i.e., hierarchical development of mental abilities based on previous growth. The stage-wise attainment is the function heredity and environment. Intellectual growth involves three fundamental processes: assimilation, accommodation, and equilibration. Assimilation involves the incorporation of new events into preexisting cognitive structures. Accommodation means existing structures change to accommodate to the new information. This dual process, assimilation-accommodation, enables the child to form schema. Equilibration involves the person striking a balance between himself and the environment, between assimilation and accommodation. When a child experiences a new event, disequilibrium sets in until

he is able to assimilate and accommodate the new information and thus attain equilibrium. Major implications include the importance of environment, stage of the learner and stage-based design of learning experiences. Children need to explore, to manipulate, to experiment, to question, and to search out answers for themselves - activity is essential. Laboratories, workshops, technologies that encourage interactivity such as multimedia, hypermedia, virtual reality fit in with Piagetian thought. Teachers can use “electronic manipulatives” that support exploration activities for appropriate stage(s) of development. Students not only can use multimedia to learn, but they can also use it to communicate their understanding of the subject to those around them. They can create what they learn by using authoring tool (Hypercard). Virtual reality has the potential to move education from its reliance on books to experiential learning in naturalistic settings. Hypermedia allows students to manipulate as they follow the path of their choice.

- (iv) **Discovery Learning** by Jerome Bruner (1960): Discovery learning believes that it is best for learners to discover facts and relationships for themselves. It is a learning situation in which the principal content of what is to be learned is not given but must be independently discovered by the student. Discovery learning takes place in problem solving situations where the learner draws on his own past experience and existing knowledge to discover facts, relationships and new truths to be learned. Students interact with the world by exploring and manipulating objects, wrestling with questions and controversies, or performing experiments. Bruner believed that children learn in a sequence of representation stages, not dependent on age. This sequence of stages applies to adults as well. In Enactive Representation, the knowledge is expressed through motor responses or actions; Iconic Representation, where images represent knowledge; and Symbolic Representation, where a combination of symbols demonstrates knowledge which cannot be represented by actions or images. Further, he specified four features for theory of instruction which are (Bower & Hilgard, 1986): predisposition to learn, i.e., the theory must concern experiences and context; structure of knowledge, i.e., specification of ways in which a body of knowledge should be structured; sequence, i.e., specification of the most effective order for presentation of instruction material and





reinforcement, i.e., specification of pacing and rewards; moving from extrinsic to intrinsic ones. Models that are based upon discovery learning model include: guided discovery, problem-based learning, simulation-based learning, case-based learning, incidental learning, among others. The four components to the Discovery Learning Theory are curiosity and uncertainty, structure of knowledge, sequencing, and motivation. There are three principles associated with this theory: firstly, instruction must be concerned with the experiences and contexts that make the student willing and able to learn (readiness), secondly, instruction must be structured so that it can be easily grasped by the student (spiral organization), and thirdly, instruction should be designed to facilitate extrapolation or fill in the gaps (going beyond the information given). Instead of being 'told' the content by the teacher, it is expected that the student will have to explore examples and from them 'discover' the principles or concepts, which are to be learned. Bruner developed the 'spiral curriculum', an educational method of building upon knowledge by revisiting a concept using different forms of representation in a continuing cycle and at a higher level of complexity. The instructional implications of Bruner's theory are backward design, higher order thinking skills, access digital information sources.

4. CONCLUSION

From the various theories of learning as given by different psychologists, it may be concluded that computers enhance student learning. The learning theories with implications are concluded in the matrix as presented in figures 1-1 and 1-2.

Objectivist Learning Theories: Directed Integration Strategies, delivering information to help students acquire and retain information and skills.

Theory	Concept of Learning	Educational Implications	Technology Implications
Behaviorist Theory B. F. Skinner	Learning is an activity that occurs in the mind through stimulus-response chains. Learning takes place as	Instruction must provide the right stimuli and reinforcement to achieve desired	Computer programs can provide structured, consistent, reliable multiple

	<p>a result of reinforcement of the behavior by a reward or a punishment.</p> <p>Learning can be inferred only by observed behaviors.</p>	<p>learned responses.</p> <p>Theory promotes objectives-based instruction, pre-assessment of learners, and mastery learning.</p>	<p>instructions and reinforcement to attain minimum competency on individual basis.</p>
<p>Information-Processing Theory</p> <p>Richard Atkinson</p>  <p>Richard M. Shiffrin</p> 	<p>Learning is information processing in the brain that contains three kinds of memory to process information: sensory registers to receive information; short-term memory to hold it temporarily; long-term memory to store information indefinitely. For new information to be in LTM, it must be linked in some way to prior knowledge already in LTM.</p>	<p>Instruction must gain attention, provide the right kinds of application, and provide sufficient practice to ensure encoding, retention, and recall.</p>	<p>Computer with multimedia capabilities provide software tools and internet resources that have qualities to attract students' attention and provide repetitive application and practice on an individual basis.</p>
<p>Cognitive-Behavioural Theory</p> <p>Robert Gagné</p> 	<p>Learning requires learners to have prerequisite skills for each new skill.</p> <p>Learning is shaped by providing instructional conditions, the nine Events of Instruction that differ according to</p>	<p>Instructional activities must provide events to support the type of learning; students must demonstrate they have learned prerequisite skills; learning hierarchies define a sequence of</p>	<p>Computers can give information on students' skill levels and follow skills hierarchy approach to accomplish all of the necessary Events of</p>





	the type of skill being taught; and a skills hierarchy approach that presents simple skills and builds to complex ones.	instruction like: intellectual skills to be learned; different instruction required for different learning outcomes.	Instruction.
<p>Systems Theory</p> <p>L. Bertalanffy</p> 	Learning is achieved by using an instructional system well designed by stating goals and objectives; doing task analysis to set a sequence of learning activities; matching assessment and instruction to objectives; creating materials; field testing and revising materials.	<p>Instruction must be structured, sequential with continuous monitoring of students' progress.</p> <p>Provides a system for assessment of students' needs, development of learning materials as learning intervention, evaluation of the effectiveness of learning intervention.</p>	Computer applications can provide a highly structured sequence of instruction, practice, and assessments, and can give fast, accurate information on each student's progress.

Figure Error! No text of specified style in document.-1. Objectivist Learning Theories

Constructivist Learning Theories: Inquiry-Based Integration Strategies, helping students explore topics and generate their own knowledge.

Theory	Concept of Learning	Educational Implications	Technology Implications
<p>Social Activism Theory</p> <p>John Dewey</p>	Learning is an individual growth that occurs through social experience. Individual growth is fostered through hands-on and	Curriculum topics should be integrated, rather than isolated, related to students' interests, to provide	Collaboration, cooperation, visual presentations; connect real world applications to abstract concepts;

	<p>experience-based activities relating to real-world issues and problems.</p>	<p>hands-on meaningful learning and to help them understand their culture through real-world connections.</p>	<p>movies; internet - a source of vast information.</p>
<p>Scaffolding Theory Lev Vygotsky</p> 	<p>Learning is cognitive development shaped by individual differences, influenced by social interactions. Adults and children perceive world differently. Difference between their levels of cognitive functioning is ZPD. Adults support learning through scaffolding, or helping children construct new knowledge, which is taken away after the learning is achieved.</p>	<p>Instruction should be customized to each student's individual cognitive level, needs and preferences.</p>	<p>Technology can help implicate scaffolding by holding multiple paths to study the same material and making use of many graphic examples, visual tools, and virtual reality, which can help students to understand complex concepts easily.</p>
<p>Child Development Theory Jean Piaget</p> 	<p>Learning is cognitive growth through genetically controlled neurological and social maturation. Children go through sequential stages of cognitive development: sensorimotor, preoperational, concrete operational, formal</p>	<p>Focus is on the environment, stage of the learner and stage-based design of learning experiences. Children need to explore, to manipulate, to experiment, to</p>	<p>Laboratories, workshops, technologies that encourage interactivity such as multimedia, hypermedia, and virtual reality fit in with Piagetian thought. Teacher can use electronic</p>


	operations, by interacting with their environment. When confront something new, causes disequilibrium, learn by assimilation and accommodation	question, and to search out answers for themselves - activity is essential.	manipulatives to support stage appropriate exploration activities.
Discovery Learning Jerome Bruner 	<p>Learning takes place in problem solving situations where the learner draws on own past experience and existing knowledge to discover facts and relationships.</p> <p>Children/adults learn in a sequence of representation stages, not dependent on age.</p>	<p>Teachers support discovery learning by providing opportunities for exploring and manipulating objects and doing experiments.</p> <p>Children understand concepts better when they discover through exploration</p>	<p>Technology provides a wealthy arrangement of information for teachers to design discovery learning opportunities and for students to explore alternatives and relationships between ideas.</p>

Figure Error! No text of specified style in document.-2. Constructivist Learning Theories

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