

## Learning Theories

*“For education the crucial question is not whether skills are implicit theories...but whether it facilitates learning to get students to think of skills in this way.” Hubert & Stuart Derives.*

**Introduction:** Educators today debate the most appropriate instructional role for technology. Today it is not simply advocating the use of computers as “tutors”, “tools” or “tutees”. (Taylor, 1980).

Trends effecting the course of educational technology:

- a) increase in the **number and types of technology** resources;
- b) dramatic **shifts in beliefs** about fundamental goals and strategies of education.

The world is changing too quickly to confine educational goals to specific information or skills - “**learning to learn**” will help future citizens. **Example:** rather than learning specific items of information, one learns how to acquire, sort and use information.

Two Views: as the goals of education begin to change, teaching strategies also change. Identifying exactly how new skills and methods will differ has become increasingly controversial. **Disagreement** served as a catalyst for two different views:

- a) **directed instruction (behaviorist learning theory);**
- b) **constuctivist (cognitive learning theory).**

There are **meaningful roles for both** views and the technology applications associated with them. Both attempts to identify to what Gagne would call the “conditions of learning”. Both are based on the work of respected learning theorists and psychologists.

They **differ** when they define learning and describe conditions required to make learning happen and the kind of problems that interfere most with learning.

Directed learning (objectivists) believe that knowledge has a **separate real existence** of its own outside the human mind - learning happens when this knowledge is transmitted to the learner.

Constructivists believe that humans **construct all knowledge in their minds**, so that learning happens when a learner constructs both mechanisms for learning and his or her own unique version of knowledge.

Merging the two approaches:

- an **either-or-stance** seems to gain little for educators
- both sides need to find a way to **merge the two approaches;**
- they need to forge a link between the two so that students can “travel” freely from one to the other.

Difference in Terminology (Directed Instruction and Constructivism)		
	To describe Directed Instruction	to describe Constructivism
Advocates of directed instruction say	Teacher directed	Discovery learning
	Systematic instruction	Unstructured learning
	Systems approaches	Self directed learning
Advocates of constructivism say	Teacher centered	Student centered
	Knowledge transfer	Knowledge construction
	Transmission models	Generative learning models

Needs addressed by Directed Instruction:

1. **Individual pacing** and remediation (especially when teacher time is limited);
2. Making **learning paths more efficient** (e.g. faster) especially for instruction in skills that are prerequisite to higher-level skills;
3. Performing time-consuming and labor-intensive tasks (e.g. skill practice) **freeing teaching time** for other, more complex student needs;
4. Supplying **self-instructional sequences**, especially when human teachers are not available, teacher time for structured review is limited, and/or students are already highly motivated to learn skills.

Needs addressed by Constructivism:

1. Making **skills more relevant** to students' backgrounds and experiences by anchoring learning tasks in meaningful, authentic (real life) highly visual situations
2. Addressing motivation problems through **interactive activities** in which students must play active rather than passive roles;
3. Teaching students how to work together to solve problems through **group based**, cooperative learning activities;
4. Emphasizing engaging, **motivational activities** that require higher-level skills and prerequisite lower-level skills at the same time.

Instructional Problems Addressed by Directed Instruction Strategies:

Real ongoing problems originated many years ago and teachers still encounter these issues:

- Post World War II: dramatic **increase in number of students** placed pressure on school resources, certification;
- **Individualization** become the goal and the terror of teachers in the 60's;
- Systems approaches were widely proposed as a way for teachers to **design self-instructional packages** as a way to design more effective teacher-delivered presentations;

- In the 70's and 80's educators began to recognize how **technology resources** (computer software and courseware) could free teachers' time to work with students who needed personal help;
- The 90's posed the problem of **too many students, too many required skills** to teach and not enough time to deal with learning differences.

Studies comparing teacher-led versus computer-based instruction in certain skill areas and with certain kinds of students have frequently found that **students can learn faster via computer-based learning systems.**

#### Instructional Problems Addressed by constructivist Strategies:

- Late 70's and 80's criticism of the educational system said that education pursued **inappropriate and outdated goals**; called for more emphasis to solve problems, find information and think critically; critics called for more "learning how to learn";
- decried the **large number of required skills**;
- **criticized traditional learning activities** that seemed abstract and unrelated to any practical skills;
- students saw **little relevance between skills** they learned in school and those they used in their daily lives;
- students did **not develop the ability to work together**;
- "passive learners" are more likely to be **poorly motivated to learn**; they are after correct answers rather than being engaged in the process of "active" learning.

Newer technology applications (e.g. Logo and hypermedia) nurture constructivist goals:

- they provide vivid **visual support**;
- make up for many students' **deficiencies** e.g. reading skills;
- **involve and motivate** students by using graphics and other devices;
- let students work together in **cooperative groups**.

#### Where does Technology fit? What do Teachers Need to Know?

Instructional problems identified by both objectivists and Constructivists are common to any school or classroom. Teachers will always:

- use **some directed instruction** as the most efficient means of teaching certain skills;
- need **motivating, cooperative learning activities** to make sure students can transfer what they learn to problems they encounter;

Therefore, **proficient technology**-oriented teachers must:

- learn to **combine** directed instruction and constructivist approaches;
- **select** technology resources and integration methods that are best suited to carry them out;

#### Some practitioners believe that:

- Constructivism will **eventually dominate** certain overall education goals and
- **systematic approaches** will assure specific prerequisite skills;
- Tennyson (1990) suggested: 30% learning time on “acquired knowledge” and 70% should be spent on the “employment of knowledge”.

Over the next decade:

1. teachers will **test Tennyson’s** and others’ proposals for merging the two systems;
2. educators will try to **identify the best mix** of approaches for each area;
3. face **new challenges** to traditional views on curriculum organization e.g.:
  - **interdisciplinary** courses versus **single** subject ones;
  - **direct teaching** or transmission of knowledge vs providing resources and **guiding learning**;
4. teachers need to know how:
  - these **methods** came about
  - each addresses **classroom needs**
  - each suggests that they **integrate technology** resources.

### Summary of Characteristics of the Two Instructional Models

Directed instructional models tend to:

1. Focus on **teaching sequences of skills** that begin with lower level skills and build to higher-level skills
2. Clearly **state skill objectives** with test items matched to them
3. Stress more **individualized work** than group work
4. Emphasize **traditional teaching and assessment** methods: lectures, skill worksheets, activities and test with specific, expected responses.

Constructivist learning models tend to:

1. Focus on learning through **posing problems, exploring** possible answers, and **developing** products and presentations
2. Pursue more **global goals** that specify general abilities such as **problem solving and research skills**
3. Stress **more group work** than individualized work
4. Emphasize **alternative learning and assessment methods**: exploration of open-ended questions and scenarios, doing research and developing products; assessment by student portfolios, performance checklists, and tests with open-ended questions; descriptive narratives written by teachers

## Theoretical Foundations of Directed Instruction:

### 1. Learning theories associated with Directed Instruction:

#### Behavioral theories:

- concentrated on **immediately observable** (thus, “behavioral”) changes in performance (e.g. tests) as indicators of learning.

#### Information-processing theories:

- developed from a branch of **cognitive psychology**
- focused on the **memory and storage process** that make learning possible.
- viewed the process of learning in human beings as similar to the way a **computer processes** information
- explored how a person **receives (senses) information** and stores it in memory;
- relating and building on something **learned previously**;
- explored how a learner retrieves information (**short and long term memory**).

### 2. Contributions of Behavioral Theorists:

B.F. Skinner                      Edward Thorndike

Richard Atkinson              David Ausubel

Robert Gagne - a leader in building upon both behavioral and cognitive theories  
- played a key role in “instructional systems” design

#### B. F. Skinner (and other behavioral theorists):

- a) considered the “**grandfather of behaviorism**”;
- b) concerned mainly with **observable indications of learning** and what indications could imply for teaching;
- c) **recognized internal processes** operated in the brain during learning, but did not attempt to describe those processes;
- d) researchers should concentrate instead on “**cause-and-effect relationships**” that could be observed;
- e) viewed the teacher’s job as **modifying the behavior of students** by reinforcing desired responses;
- f) viewed learning as **a sequence of stimulus and response** action in the learner;
- g) “**Chaining**” the lower-order skills would enable students to solve the higher-order problems.

#### These behavioral principles underlay two well known trends in education:

- **behavior modification techniques** in classroom management;
- **programmed instruction** (basis of effective drill and practice and tutorial courseware).

### **3. The Contribution of Information Processing Theories:**

Many educational psychologists:

- found **emphasis on observable outcomes** of learning unsatisfying;
- did not agree with the behaviorists' view that **stimulus-response** learning alone could form the basis for building higher-level skills;
- when focusing on rule learning and problem solving, they became **more concerned with internal process** (inside the brain) that went on during learning;

Information Processing Theorists:

- based their work on a model of memory proposed by Richard Atkinson (1968) - derived their **constructs from computer science**;
- **input** variables (information to be learned)
- **processing** component (attention and expectancies working with short term and long term memory)
- **output** variables (outward indication that a process has taken place)

### **4. Characteristics of Directed Instruction:**

Teaching methods are:

- based primarily upon **behaviorist and information-processing** learning theories;
- associated with **traditional**, teacher-directed forms of instruction;
- **Robert Gagne** is considered a leader in developing instructional guidelines for directed instruction that combine the behavioral and information-processing learning theories;
- Gagne asserted that teacher **must accomplish** at least three tasks:
  - \* assure prerequisite skills (referred to this groups of skills as a learning hierarchy);
  - \* supply instructional conditions (supply sequences of carefully structured presentations and activities to help students understand, remember and transfer information and skills [see below];
  - \* determine the type of learning (teachers must vary these conditions for each of several different kinds of learning).

Systematic instructional design (or systems approaches):

- a) incorporated information from learning theories into **step-by-step procedures** for preparing instructional materials (adopted more by military and industry trainers);
- b) contributed to **courseware development** (design of self contained tutorial packages);
- c) teachers, **when preparing components** of their instructional system, need to identify:
  - instructional goals and objectives;

- instructional analysis (task analysis);
- tests and measures;
- instructional strategies;
- evaluating and revising instruction.

#### 5. **Directed Methods: Problems and Possibilities:**

- a) The learning theories and instructional design approaches associated with directed instruction have had at least in part, a **negative impact**;
- b) behavioral principles and systematic methods was found to **teach skills successfully - but boring**;
- c) resulted in strong attention to required **performance objectives** and **individual skill testing**;
- d) **“teaching to the tests”** made curriculum very dry and disconnected from any application outside the classroom;
- e) Constructivists approaches are in part, a **backlash** against the perceived regimentation;
- f) greatest current criticisms of directed methods is their **irrelevance to the needs of today’s students** - critics put forward these problems:
  - students cannot do problem solving;
  - students find directed instruction activities unmotivating and irrelevant;
  - students cannot work cooperatively.

#### In modern classrooms teachers:

- do not use **programmed instruction** to teach skills;
- do not design many **individual lessons** with specific objectives and tests for each;
- use **lesson plans** primarily to communicate clearly to others (Head of School, E.O.’s);
- do not consider **strict sequences** for lesson plans;  
but
- teachers must still **arrange conditions** of learning;
- must still answer the question “...**have the students learned** what I expected them to learn?”
- consider some **current uses of directed instruction** based on behaviorist principles e.g.:
  - **fluency** practice (in reading and math skills);
    - **performance** management criteria (to improve study habits);
    - structured, **teacher-directed techniques** (to teach problem solving and higher order skills);
    - proposed application of **behavioral techniques** (to lead to creativity).

### **Theoretical Foundations of Constructivism**

*“Constructivism comes in different strengths...from weak to moderate to extreme” (Molenda 1991).* The differences among those who think of themselves as constructivists make it very difficult to settle on a single definition for constructivism.

### **1. Learning Theories Associated with Constructivism:**

Constructivist strategies are based on principles from branches of cognitive science. This area focused on:

1. students’ **motivation** to learn;
2. their ability **to use what they learn** outside the school;
3. a remedy to perceived **deficiencies** in behaviorist and information processing theories;
4. trying to **inspire** students to see the relevance of what they learn;
5. preventing what the CTVG “**inert knowledge**” (the failure of students to transfer what they know to the learning of other skills that require the prior knowledge.

### **2. Contributions of Early Cognitive Learning Theories:**

(John Dewey, Lev Vygotsky, Jean Piaget, Jerome Bruner and Seymour Papert)

J. Dewey - the need to center instruction around **activities** that are relevant and meaningful to a student’s own experience.

Lev Vygotsky - concept of “**scaffolding**” and the “**zone of proximal development**”. This is the gap between the student-novice and the teacher-expert. “Scaffolding” is when the school helps the student to bridge this gap by relying on the assistance provided by expert problem solvers (teachers) to novices (students) for example by building on the child’s experiences. Vygotsky emphasized the importance of **social relations** in all forms of complex mental activity”. Teachers can most effectively provide scaffolding, or assistance in acquiring knowledge through **supervised collaborative learning** activities.

Piaget - is regarded as a major contributor of theoretical **principles of constructivism**. He felt that a child passes through a series of stages of cognitive development:

- **Sensorimotor** stage (birth to 2 years): children explore world around them through their senses;
- **Preoperational** stage (2 to about 7): abilities to communicate through speech, develop numerical abilities, increase level of self control but unable to do “conservation tasks” (e.g. realize that shape is not related to quantity);
- **Concrete operational stage**: increase in abstract reasoning, can do conservation tasks;
- **Formal operations stage** (about 12 to 15): can form and test hypotheses, organize information and reason scientifically, can show result of abstract thinking (writing, drama).

**Assimilation:** children fit new experience into their existing schemes or patterns of behavior based on what they learn;

**Accommodation:** some times they change their existing schemes to incorporate new experiences.

Piaget advocated **non intervention**, saying that “Everything one teaches a child prevents him from inventing or discovering”.

J. Bruner: his theories **coincide** with those of Piaget.

- Believed children go through various **stages of intellectual development** :
- **enactive** - (birth to about 3): perceive the environment solely through actions that they initiate;
- **Iconic** - (3 to about 8): remember and use information through imagery (mental pictures or icons);
- **Symbolic** - (8 onwards): use of symbols (words or draw pictures), think and talk about things in abstract form, can better understand mathematical principles.

Bruner **supported intervention** and he believed that teachers could accomplish this by encouraging active participation in the learning process. This was best achieved through discovery learning environments that would let children explore alternatives and recognize relationships between ideas.

Most constructivists call for instructional intervention, that is, for teachers to **provide learning activities** to match and accelerate movement through these stages.

Seymour Papert: mathematician and pupil of Piaget. One of the first vocal critics of **using technology in the context of traditional instructional methods** and has profoundly influenced the field of educational technology. He began experimenting with LOGO.

- Characterized children as “**builders of their own intellectual structures**”;
- believed that even very young children could **accelerate their development** and learn concepts involving formal operations;
- the most important learning was “**learning without being taught**”;
- schools put too much **emphasis on structured** teaching;
- said that the purpose of education was to provide rich, motivational environments **to foster cognitive growth** and felt that computers could make possible such environments;
- LOGO offered what he termed as “**microworlds**”: self contained orderly environments that children could use as “incubators of knowledge”. He believed that children should be allowed to teach themselves with LOGO.

### **3. Vanderbilt’s Cognition and Technology Group (VCTG) - anchored instruction.**

A group of researchers at Vanderbilt built on the concepts of **situated cognition** and **collaborative learning introduced** by Brown et al as well as Vygotsky's concept of **scaffolding**.

- **Criticized many of today's educational practices** (especially in mathematics) as harmful and ineffective;
- **described anchored instruction**: teaching that is “situated in engaging, problem-rich environments that allow sustained exploration by students and teachers”
- advocated that “**self-generated information** is better remembered than passively received information”;
- recommended that students not only **create answers** to problems, but also **generate many aspects** of the problem statements themselves. Referred to this as “generative learning”

#### **4. Cognitive flexibility theory and radical constructivism.**

Spiro et al. Say that current classroom methods are more suited to learning in well-**structured knowledge domains** while much of what students should learn lies in “**ill-structured domains**”. (compare basic arithmetic structures to applying arithmetic in solving word problems).

They say that the “new constructivism” of their theory is “**doubly constructive**” because it calls for students to generate not only solutions to new problems, but also the prior knowledge needed to solve the problems.

Perkins calls this difference **BIG (beyond the information given)** and **WIG (without the information given)**. Spiro et al. Are referred to as *radical constructivists* because they call for an even greater departure from directed instruction methods than other Constructivists.

#### **5. Characteristics of Constructivism:**

1. image of **changing the traditional goals** of education;
2. making possible **restructured, innovative teaching** approaches;
3. emphasized students' ability to **solve real-life, practical problems**;
4. learners **construct knowledge themselves**;
5. students typically **work in cooperative groups** rather than individually;
6. they tend to **focus on projects** that require solution to problems rather than on instructional sequences;
7. the job of the teacher is to **arrange for required resources**;
8. the teacher acts as a **guide to students** while they set their own goals and “teach themselves”.

Problems of putting into practice the principles of cognitive theorists:

1. teachers need to **rethink traditional views** on both objectives and methods of instruction
2. they need to **experiment with new ways** of facilitating
3. teachers are still **bound by constraints** of required curricula
4. teachers must ensure that students **accomplish school or national exam** objectives;
5. instructional activities based on Constructivist models are **more time-consuming** as they need to organize group work; paper and pencil tests are easier and quicker;
6. teachers have **limited information** available on how to smooth classroom implementation or what problems to anticipate (especially when using interactive video and multimedia);
7. Teachers must **analyze the needs** of their students and decide which constructivist strategies seem appropriate for meeting these needs.

### **6. Required characteristics of constructivist approaches:**

1. Problem-oriented activities
  - a) focus on students solving problems
  - b) problems may be posed in terms of specific goals
    - i) “what if” questions
    - ii) open ended questions
2. Visual formats and mental models
  - a) CTVG: instructional activities help students build good “mental models” of problems to be solved;
  - b) teachers pose problems in visual (as opposed to written) formats
  - c) this is particularly important for low achievers
3. “Rich” environments
  - a) call for “richer learning environments” in contrast to the minimalist classroom environment which relies primarily on the teacher, textbook or worksheets
  - b) Perkins observes that models are facilitated by:
    - i) information banks (textbooks, electronic encyclopedias)
    - ii) symbol pads (notebooks, laptop computers)
    - iii) construction kits (Legos, Logo)
    - iv) phenomenaria (terrarium, computer simulation)
    - v) task managers (teachers, electronic tutors - CAI)
4. Cooperative or collaborative (group) learning
  - a) heavily emphasis work in groups - best way for generative learning
  - b) illustrates distributive intelligence at work
  - c) seems an ideal environment for students to learn how to share responsibility and work together toward common goals
5. Learning through exploration
  - a) call for **flexibility** in achieving desired goals
  - b) stress **exploration** rather than getting the right answer
  - c) can be termed as “**discovery learning**”

- d) only a few constructivists feel that students should have **complete freedom and unlimited time** to discover the knowledge they need
- 6. Authentic assessment methods
  - a) teachers need new **methods of evaluating** student progress
  - b) constructivist approaches show **more qualitative assessment** strategies rather than quantitative
  - c) some popular assessment methods are:
    - i) **portfolios** with examples of students' work
    - ii) **products** they have developed
    - iii) **narratives** written by teachers to describe each student's work habits, areas of strengths and weaknesses
    - iv) **performance-based assessment** in combination with checklists of criteria for judging students' performance (Linn 1994)

### **Constructivist Methods: Problems and Possibilities:**

1. **How can one certify skill learning?** - constructivists deplore formal tests or "objective measurements, but schools must certify that students have learned key skills;
2. **How much prior knowledge is needed?** - many students may lack the prerequisite abilities that would allow them to handle this kind of problem solving;
3. **Can students choose the most effective instruction?** - a study by Clark indicated that students often learn the least from instructional methods they prefer most;
4. **Which topics suit constructivist methods?** - activities frequently seek to teach the problem-solving area (e.g. think like a historian) rather than to learn any specific content or skills (e.g. historical facts);
5. **Will skills transfer to practical situations?** - Tobias found little evidence from related research to indicate that such transfer will occur;
6. **What objective evidence demonstrates the effects of constructivist methods?** - constructivist claims seem appealing but, according to Tobias, they have never been scientifically investigated.

*Despite these criticisms, interest in constructivist methods is on the rise. It seems likely that the next decade will witness some dramatic shifts in curriculum goals and methods that follow constructivist principles in large part. Many educators seem to believe that they cannot make curriculum reflect constructivist characteristics **without** technology.*

### **Technology Integration Strategies: Directed and Constructivist Approaches**

*Teachers may find themselves using many or all of the following strategies at the same time. However, it is important to recognize that each of the integration strategies described here addresses a specific instructional need. They are not employed to make students computer literate. It is advisable to make a conscious effort to match technology resources to problems that educators cannot address in other ways.*

1. **Integration Strategies Based on Directed Models:**

Integration to:

- a) remedy identified weaknesses
- b) promote fluency or automaticity of prerequisite skill
- c) make learning efficient for highly motivated students
- d) optimize scarce resources
- e) remove logistical hurdles

2. **Integration Strategies Based on Constructivist Models:**

Integration to:

- a) generate motivation to learn
- b) foster creativity
- c) facilitate self-analysis and metacognition
- d) increase transfer of knowledge to problem solving
- e) foster group cooperation

**Combining Integration Strategies in Curriculum Planning**

Following are some recommended guidelines for Developing a Technology-Integrated Curriculum plan based on discussions with teachers:

- a) plan for a grading period (e.g. a month, term or school year)
- b) allow enough time
- c) match the assessment to the activity
- d) be flexible
- e) don't be afraid to experiment

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