Table of Contents

Handouts

- Grounded Instructional Strategies................................................................. 2
- Grounded Instructional Events............................................................... 24
- Standards for Assessing Critical Thinking and Reasoning................................. 27
Grounded Instructional Strategies

Grounded instructional strategies are rooted in established theories of and research on human learning. They form the basis for designing and sequencing meaningful e-learning interactions and for creating online, hybrid and conventional classroom learning environments. Table 1 outlines the primary instructional events associated with published instructional strategies that are grounded and grouped according to major classes of learning theories. Guidelines and criteria for selecting an instructional strategy follow, along with further details about each strategy.

Table 1. Primary events associated with grounded instructional strategies

<table>
<thead>
<tr>
<th>Constructivist (Learner-Centered) Approaches</th>
<th>Experiential Learning Model</th>
<th>Guided Experiential Learning</th>
</tr>
</thead>
<tbody>
<tr>
<td>(Pfeiffer &amp; Jones, 1975)</td>
<td>(Kolb, 1984)</td>
<td>(Clark, 2004)</td>
</tr>
<tr>
<td>1. Experience</td>
<td>1. Concrete Experience</td>
<td>1. Goals</td>
</tr>
<tr>
<td>2. Publish</td>
<td>2. Reflective Observation</td>
<td>2. Reasons and Activation</td>
</tr>
<tr>
<td>5. Generalize</td>
<td></td>
<td>5. Integration</td>
</tr>
<tr>
<td>6. Apply</td>
<td></td>
<td>6. Assessment</td>
</tr>
</tbody>
</table>

<table>
<thead>
<tr>
<th>Experiential Learning Model</th>
<th>Problem-Based Learning Model</th>
<th>Collaborative Problem-Solving</th>
</tr>
</thead>
<tbody>
<tr>
<td>2. Start a New Problem</td>
<td>2. Form and Norm Groups</td>
<td>2. Retrieve Similar Cases</td>
</tr>
<tr>
<td>4. Performance Presentation(s)</td>
<td>4. Define and Assign Roles</td>
<td>4. Revise Proposed Solution</td>
</tr>
<tr>
<td>5. After Conclusion of Problem</td>
<td>5. Engage in Problem-Solving</td>
<td>5. Retain Useful Experiences</td>
</tr>
</tbody>
</table>

| Learning by Doing                           | WebQuest                    | Case-Based Reasoning        |
| 1. Define Goals                             | 1. Introduction              | 1. Present New Case          |
| 2. Set Mission                              | 2. Task                      | 2. Retrieve Similar Cases    |
| 5. Operate Scenarios                        | 5. Evaluation                | 5. Retain Useful Experiences|
| 6. Provide Resources                        | 6. Conclusion                |                             |
| 7. Provide Feedback                         |                             |                             |

| BSCS SE Model                               | Inquiry Training             | Inductive Thinking          |
| 1. Engage                                   | 1. Confrontation with the Problem| 1. Concept Formation        |
| 2. Explore                                  | 2. Data Verification          | 2. Interpretation of Data   |
| 4. Elaborate                                | 4. Organizing, Formulating and Explanation|                     |
| 5. Evaluate                                 | 5. Analysis of inquiry process|                             |
| 6. Evaluate                                 |                             |                             |

| Simulation Model                            |                             |                             |
| (Joyce, Weil, & Showers, 1992)              |                             |                             |
| 1. Orientation                              |                             |                             |
| 2. Participant Training                      |                             |                             |
| 3. Simulation Operations                    |                             |                             |
| 4. Participant Debriefing                    |                             |                             |
| 5. Appraise and redesign the simulation     |                             |                             |
Table 1 (con’t). Primary events associated with grounded instructional strategies

<table>
<thead>
<tr>
<th>Constructivist (Learner-Centered) Approaches (con’t)</th>
<th>Scaffolded Vee Diagram</th>
<th>Historical Inquiry</th>
</tr>
</thead>
<tbody>
<tr>
<td>Jurisprudential Inquiry (Oliver &amp; Shaver, 1971)</td>
<td>(Crippen, Archambault, &amp; Kern, in press)</td>
<td>(Waring, 2011)</td>
</tr>
<tr>
<td>1. Orientation to the Case</td>
<td>1. Big Problem</td>
<td>1. A Hook</td>
</tr>
<tr>
<td>2. Identifying the Issues</td>
<td>2. Initial Ideas</td>
<td>2. Identify Fundamental Questions</td>
</tr>
<tr>
<td>4. Exploring the Stance(s)</td>
<td>4. Analysis and Artifacts</td>
<td>4. Recognize Multiple Perspectives and Historic Causation</td>
</tr>
<tr>
<td>5. Refining and Qualifying the Positions</td>
<td>5. Claims</td>
<td>5. Create Plausible Narratives</td>
</tr>
<tr>
<td></td>
<td>7. Reflection</td>
<td>7. Reflect on Experience</td>
</tr>
</tbody>
</table>

Adaptive Instructional Design (Schwartz, Lin, Brophy & Bransford, 1992)

1. Look Ahead & Reflect Back
2. Present Initial Challenge
3. Generate Ideas
4. Present Multiple Perspectives
5. Research and Revise
6. Test Your Mettle
7. Go Public
8. Progressive Deepening
9. General Reflection and Decisions
10. Assessment


1. Set Learning Challenge
2. Negotiate Goals and Objectives
3. Negotiate Learning Strategy
4. Construct Knowledge
5. Negotiate Performance Criteria
6. Assess Learning
7. Provide Feedback (Steps 1-6)
8. Communicate Results

Historical Inquiry (Waring, 2011)

1. A Hook
2. Identify Fundamental Questions
3. Engage in Primary and Secondary Sources
4. Recognize Multiple Perspectives and Historic Causation
5. Create Plausible Narratives
6. Assess Skills, Knowledge and Attitudes
7. Reflect on Experience

Behavioral & Cognitive Information Processing (Teacher-Directed) Approaches

Nine Events of Instruction (Gagne, 1977, 1974)

1. Gain Attention
2. Inform Learner of Objective(s)
3. Recall Prior Knowledge
4. Present Stimulus Materials
5. Provide Learning Guidance
6. Elicit Performance
7. Provide Feedback
8. Assess Performance
9. Enhance Retention and Transfer

Direct Instruction (Joyce, Weil, & Showers, 1992)

1. Orientation
2. Presentation
3. Structured Practice
4. Guided Practice
5. Independent Practice

Five Component Lesson Model (Dick, Carey, & Carey, 2009)

1. Pre-Instructional Activities
2. Content Presentation and Learning Guidance
3. Learner Participation
4. Assessment
5. Follow Through Activities

Elements of Lesson Design (Hunter, 1990)

1. Anticipatory Set
2. Objective and Purpose
3. Input
4. Modeling
5. Check for Understanding
6. Guided Practice
7. Independent Practice

Elements of Lesson Design (Dick, Carey, & Carey, 2009)

1. Pre-Instructional Activities
2. Content Presentation and Learning Guidance
3. Learner Participation
4. Assessment
5. Follow Through Activities

Elements of Lesson Design (Hunter, 1990)

1. Anticipatory Set
2. Objective and Purpose
3. Input
4. Modeling
5. Check for Understanding
6. Guided Practice
7. Independent Practice

Elements of Lesson Design (Hunter, 1990)

1. Anticipatory Set
2. Objective and Purpose
3. Input
4. Modeling
5. Check for Understanding
6. Guided Practice
7. Independent Practice
### Neuro-Biological Approaches

<table>
<thead>
<tr>
<th>Principles of Natural Learning</th>
<th>Brain-Based Teaching</th>
<th>Interplay Strategy</th>
</tr>
</thead>
</table>
1. **Relaxed Alertness**  
   a. Challenge enhances, threat inhibits learning  
   b. Social brain/mind  
   c. Innate search for meaning  
   d. Emotions are critical to patterning  
2. **Orchestrated Immersion**  
   a. The brain processes parts and whole  
   b. All learning engages the physiology  
   c. Meaning occurs through patterning  
   d. Learning is developmental  
3. **Active Processing**  
   a. Two types of memory: Declarative and Procedural  
   b. Learning involves both focused attention and peripheral perception  
   c. Learning is both conscious and unconscious  
   d. Each brain is uniquely organized  
1. Malleable memories  
2. Non-conscious experience runs automated behaviors  
3. Reward and addiction dependency  
4. Attentional limitations  
5. Brain seeks and creates understanding  
6. Rough drafts/Gist learning  
7. Input limitations  
8. Perception influences our experience  
9. Malleability/Neural plasticity  
10. Emotional-Physical state dependency  
1. Expose  
2. Inquire  
3. Discover  
4. Create  
5. Experiment  
6. Share

### Alternative Approaches

|-------------------------------|-------------------|------------------------|
1. Create an experience  
2. Reflect/Analyze experience  
3. Integrate reflective analysis  
4. Develop concepts/skills  
5. Practice defined “givens”  
6. Practice adding something  
7. Analyze application  
8. Apply to new experience  
1. Summarize  
2. Question  
3. Response  
1. Survey  
2. Question  
3. Read  
4. Recite  
5. Review
Inquiry, Experiential and Problem-Based (Learner-Centered) Approaches

Experiential Learning Model
(Pfeiffer & Jones, 1975)

Based on the belief that people learn best by doing, the experiential learning model can start with didactic (passive) forms of instruction but soon progresses to experiential (active) forms of learning.

1. Experience – Immerse learner in “authentic” experience (e.g., real or simulated job task).
2. Publish – Talking or writing about experience. Sharing observations, thoughts, and feelings.
5. Generalize – Develop hypotheses, form generalizations and reach conclusions from information and knowledge gained from lesson.
6. Apply – Use information and knowledge gained from lesson to make decisions and solve problems.

Experiential Learning
(Kolb, 1984)

Building upon earlier work by John Dewey and Kurt Levin, American educational theorist Kolb believed that “learning is the process whereby knowledge is created through the transformation of experience” (1984, p. 38). The theory presents a cyclical model of learning, consisting of four stages shown below. One may begin at any stage, but must follow each other in the sequence:

1. Concrete experience (or “DO”) - Where the learner actively experiences an activity such as a lab session or field work.
2. Reflective observation (or “OBSERVE”) - When the learner consciously reflects back on that experience.
3. Abstract conceptualization (or “THINK”) - Where the learner attempts to conceptualize a theory or model of what is observed
4. Active experimentation (or “PLAN”) - Where the learner is trying to plan how to test a model or theory or plan for a forthcoming experience

Kolb’s four-stage learning cycle shows how experience is translated through reflection into concepts, which in turn are used as guides for active experimentation and the choice of new experiences. Kolb identified four learning styles which correspond to these stages. The styles highlight conditions under which learners learn better. These styles are:

- Assimilators, who learn better when presented with sound logical theories to consider
- Convergers, who learn better when provided with practical applications of concepts and theories
- Accommodators, who learn better when provided with “hands-on” experiences
- Divergers, who learn better when allowed to observe and collect a wide range of information
Clark’s (2004) Guided Experiential Learning (GEL) fosters skill development and the learning of factual information in the context of how it will be used. It assumes that learning occurs best in context of a goal that is relevant, meaningful, and interesting to students; and (b) content knowledge is best learned in context of relevant tasks closely related to how students will use it outside of the learning environment.

1. **Goals** – Including learning objectives, problems to be solved, what students will be able to do at the end of the lesson.
2. **Reasons and Activation** – Rationale and overview for the goals and objectives. Answers questions about value and utility such as: “Why is learning to do this important to me?” “What value does it hold for me, my job, mission or my team?” “What risk will I avoid if I learn it?” Briefly describe (and when possible, provide a visual model of the location of) the lesson in the larger course and sequence of lessons and then describe the instructional strategy.
3. **Demonstration** – Promotes learning by demonstrating what is to be learned rather than merely telling information about what is to be learned. The demonstration can direct students to relevant information and provide multiple representations or scenarios for comparison. The demonstration should also be accompanied by job aids that summarize the action and decision steps.
4. **Application** – Students are required to use their new knowledge or skill to solve problems or show comprehension of new concepts.
5. **Integration** – Students are encouraged to integrate (transfer) the new knowledge or skill by the following activities:
   1.1 Watch me: Gives students the opportunity to publicly demonstrate their new knowledge or skill.
   1.2 Reflection: Asks students to reflect-on, discuss, and defend their new knowledge or skill.
   1.3 Creation: Encourages students to create, invent, and explore new and personal ways to use their new knowledge.
6. **Assessment** – Practice must be reviewed and checked against a list of concepts or action and decision steps derived from standard procedures.
Learning by Doing
(Schank, Berman & Macpherson, 1999)

The primary goal is to foster skill development and the learning of factual information in the context of how it will be used. Assumes that learning occurs best in context of a goal that is relevant, meaningful, and interesting to students, and when content knowledge is learned in context of relevant tasks closely related to how students will use it outside of the learning environment.

1. Define Goals
   1.1 Process knowledge goals
   1.2 Content knowledge goals

2. Set Mission
   2.1 Must be motivational
   2.2 Must be somewhat realistic

3. Present Cover Story
   3.1 Must be motivating and create the need for the mission
   3.2 Must allow opportunities to practice the skills and seek the knowledge

4. Establish Roles (who the students will play)
   4.1 Must be one who uses the necessary skills and knowledge
   4.2 Must be motivating

5. Operate Scenarios
   5.1 Must be closely related to both the mission and the goals
   5.2 Must have decision points with consequences that become evident
   5.3 The consequences must indicate progress toward completing the mission
   5.4 A negative consequence must be understand as an expectation failure
   5.5 Plenty of operations for students to do (most time practicing skills)
   5.6 Should not require more than what the goals call for

6. Provide Resources
   6.1 Provide the information the students need to succeed in their mission
   6.2 Information must be well organized and readily accessible
   6.3 Information is often best provided in the form of stories

7. Provide Feedback
   7.1 Must be situated, so it is indexed properly as an expectation failure
   7.2 Must be just-in-time, so the student will use it
   7.3 Can be given in three ways (a) consequences of actions, (b) coaches, (c) domain experts’ stories about similar experiences.
Problem-Based Learning
(Barrows, 1985; Boud & Feletti; 1997)

Disenchanted with medical students’ ability to apply information learned from lectures, Barrow’s developed this model to enhance transfer.

1. Start New Class
   1.1 Introductions
   1.2 Climate Setting (including teacher/tutor role)

2. Start New Problem
   2.1 Set problem
   2.2 Bring problem home
   2.3 Describe the product/performance required
   2.4 Assign tasks
   2.5 Reason through the problem (i.e., ideas/hypotheses, facts, learning issues and action plan).
   2.6 Commitment as to probable outcome
   2.7 Learning issues shaping/assignment
   2.8 Resource identification
   2.9 Schedule follow-up

3. Problem Follow-Up
   3.1 Resources used and their critique
   3.2 Reassess the problem (i.e., ideas/hypotheses, facts, learning issues and action plan).

4. Performance Presentation(s)

5. After Conclusion of Problem
   5.1 Knowledge abstraction and summary
   5.2 Self-evaluation
Collaborative Problem-Solving (Nelson, 1992) The goals are to develop content knowledge in complex domains, problem-solving and critical thinking skills, and collaborative skills. It should only be used when those types of learning are paramount and when the students and instructor are receptive to this approach to learning, with its shift in roles and power relationships.

1. Build Readiness
   1.1 Overview of collaborative problem solving process
   1.2 Develop an authentic problem or project to anchor instruction
   1.3 Provide instruction and practice in group process skills
2. Form and Norm Groups
   2.1 Form small heterogeneous work groups
   2.2 Encourage groups to establish operational guidelines
3. Determine Preliminary Problem
   3.1 Negotiate a common understanding of the problem
   3.2 Identify learning issues and goals
   3.3 Brainstorm preliminary solutions or project plans
   3.4 Select and develop initial design plan
   3.5 Identify sources of needed resources
   3.6 Gather preliminary information to validate the design plan
4. Define and Assign Roles
   4.1 Identify the principal roles needed to complete the design plan
   4.2 Negotiate the assignment of roles
5. Engage in Problem-Solving
   5.1 Refine and evolve the design plan
   5.2 Identify and assign tasks
   5.3 Acquire needed information, resources, and expertise
   5.4 Disseminate acquired information, resources, and expertise to group
   5.5 Engage in solution or project, report contributions and group activities
   5.6 Participate in intergroup collaborations and evaluations
   5.7 Conduct formative evaluations of the solution or project
6. Finalize Solution
   6.1 Draft the final version of solution or project
   6.2 Conduct final evaluation or usability test of the solution or project
   6.3 Revise and complete the final version of the solution or project
7. Synthesize and Reflect
   7.1 Identify learning gains
   7.2 Debrief experiences and feelings about the process
   7.3 Reflect on group and individual learning processes
8. Assess Products and Processes
   8.1 Evaluate the products and artifact created
   8.2 Evaluate the processes used
9. Provide Closure
BSCS 5E Model
(BSCS, 2005; Bybee, 2002)

The natural inquiry of children and problem-solving of adults follow a pattern of initial engagement, exploration of alternatives, formation of explanations, use of the explanations, and evaluation of the explanations based on efficacy and others. Activities encourage conceptual change and a progressive reforming of ideas.

1. **Engage** activities provide the opportunity for teachers to identify students’ current concepts and misconceptions. Although provided by a teacher or structured by curriculum materials, these activities introduce major ideas in problem situations. How do students’ explain this situation?

2. **Explore** activities provide a common set of experiences for students and opportunities for them to “test” their ideas with their own experiences and those of peers and the teacher. How do students’ exploration and explanation of experiences compare with others?

3. **Explain** activities provide opportunities for students to use their previous experiences to recognize misconceptions and to begin making conceptual sense of the activities through construction of new ideas and understandings. Allows introduction of formal language, terms and content information that makes students’ previous experiences easier to describe and explain.

4. **Elaborate** activities apply or extend the student’s developing concepts in new activities and relate their previous experiences to the current activities. How does the new explanation work in a different situation?

5. **Evaluate** activities serve as a summative assessment of what students know and can do. How do students understand and apply concepts and abilities?

WebQuest
(Dodge, 1998)

WebQuest is an inquiry-oriented strategy in which most or all of the information used by learners is drawn from the Web.

1. **The Introduction** orients students and captures their interest
2. **The Task** describes the activity’s end product
3. **The Process** explains strategies students should use to complete the task
4. **The Resources** are the Web sites students use to complete the task
5. **The Evaluation** measures the results of the activity
6. **The Conclusion** sums up the activity and encourages students to reflect on its process and results
Case-Based Reasoning  
(Aamodt & Plaza, 1994)

Case-based reasoning is a problem solving paradigm that utilizes the specific knowledge of previously experienced, concrete problem situations (cases). A new problem is solved by finding a similar past case, reusing it in the new problem.

1. **Present**: new case or problem
2. **Retrieve**: Given a target problem, retrieve cases from memory that are relevant to solving it. A case consists of a problem, its solution, and, typically, annotations about how the solution was derived.
3. **Reuse**: Map the solution from the previous case to the target problem. This may involve adapting the solution as needed to fit the new situation. In the pancake example, Fred must adapt his retrieved solution to include the addition of blueberries.
4. **Revise**: Having mapped the previous solution to the target situation, test the new solution in the real world (or a simulation) and, if necessary, revise. Suppose Fred adapted his pancake solution by adding blueberries to the batter. After mixing, he discovers that the batter has turned blue -- an undesired effect. This suggests the following revision: delay the addition of blueberries until after the batter has been ladled into the pan.
5. **Retain**: After the solution has been successfully adapted to the target problem, store the resulting experience as a new case in memory. Fred, accordingly, records his newfound procedure for making blueberry pancakes, thereby enriching his set of stored experiences, and better preparing him for future pancake-making demands.

Simulation Model  
(Joyce, Weil, & Showers, 1992)

Based on the application of cybernetic principles to education, the purpose of this model is to help students develop skills and knowledge by examining the consequences of their actions.

1. **Orientation**
   1.1 Present broad topic of simulation and major concepts
   1.2 Explain simulation and gaming
   1.3 Give overview of the simulation
2. **Participant Training**
   2.1 Set-up scenario (rules, roles, procedures, scoring, types of decisions, goals)
   2.2 Assign roles
   2.3 Hold abbreviated practice session
3. **Simulation Operations**
   3.1 Conduct game activity and game administration
   3.2 Feedback and evaluation (of performance and effects of decisions)
   3.3 Clarify misconceptions
   3.4 Continue simulation
4. **Participant Debriefing**
   4.1 Summarize events and perceptions
   4.2 Summarize difficulties and insights
   4.3 Analyze process
   4.4 Compare simulation activity to the real world
   4.5 Appraise and redesign the simulation
Inquiry Training Model
(Joyce, Weil, & Showers, 1992)

This model is designed to promote strategies of inquiry and the values and attitudes that are essential to an inquiring mind including: process skills (e.g., observing, collecting and organizing data), active learning, verbal expression, tolerance of ambiguity, and logical thinking.

1. **Confrontation** with the Problem
   1.1 Explain inquiry procedures
   1.2 Present discrepant event
2. **Data Gathering** - Verification
   2.1 Verify nature of objects and conditions
   2.2 Verify the occurrence of the problem situation
3. **Data Gathering** - Experimentation
   3.1 Isolate relevant variables
   3.2 Hypothesize (and test) casual relationships
4. **Organizing, Formulating and Explanation** - Formulate rules or explanations
5. **Analysis of Inquiry Process** - Analyze inquiry strategy and develop more effective ones.

Inductive-Thinking Model
(Taba, 1967)

Based on information-processing theories of human learning, the inductive-thinking model was developed to enhance students’ acquisition of concepts, information processing skills as well as their convergent use of information to solve problems.

1. **Concept Formation**
   1.1 Enumeration and listing
   1.2 Grouping
   1.3 Labeling, Categorizing
2. **Interpretation of Data**
   2.1 Identify critical relationships
   2.2 Explore relationships
   2.3 Make inferences
3. **Application of Principles**
   3.1 Predicting consequences, explaining unfamiliar phenomena, hypothesizing
   3.2 Explaining and/or supporting the predictions and hypotheses
   3.3 Verifying predictions

Jurisprudential Inquiry Approach
(Oliver & Shaver, 1971)

Based on Socratic modes of discussion, the purpose of this model is to help students resolve complex, controversial issues within the context of a productive social order:

1. **Orientation** to the Case
2. **Identifying** the Issues
3. **Taking** Positions
4. **Exploring** the Stance(s), patterns of argumentation
5. **Refining and Qualifying** the positions
6. **Testing** Factual Assumptions behind qualified positions
A Scaffolded Vee Diagram serves as a guide for autonomous learning. The diagram supports students as they engage in the process of generating a scientific argument while focusing their attention on the elements of scientific knowledge (Figure 1).

Figure 1. A modified form of Gowin’s Vee diagram.

1. **Big Question.** Contextualizes the inquiry and triggers motivation. Each lesson focuses on answering a big question that is based on relevant, real world problem.
2. **Initial Ideas.** Capture student ideas related to the concepts associated with the Big Question.
3. **Concept Map.** A semantic representation of student understanding.
4. **Analysis and Artifacts.** Produces a set of data in the form of an artifact that will be used in constructing a scientific claim.
5. **Claims.** Describes an evidence-claim-reason related to the big question.
6. **Expert Opinion.** Describes the scientific knowledge related to the big question.
7. **Reflection.** Analyzes and critiques how students’ ideas are similar and different.

**Authentic Historical Inquiry**

History is about the names, dates and events, but to spark students’ interest and make connections between history and real life, instruction must shift from memorization to investigations that allow for the construction of authentic historical narratives. We must expose students to skills and knowledge in ways that are authentic and true to the methods used by professionals in the field. In other words, instead of teaching history, we should teach students how to be historians.

1. **A Hook.** Engage students with a thought provoking image, document, or other source related to the content or an activity that involves a process or concept similar to what is needed in the inquiry.
2. **Identify Fundamental Questions.** Students must have opportunities to ask and answer questions of personal interest.
3. **Engage in Primary and Secondary Sources.** A variety of sources (published or unpublished documents, oral histories, visual documents, artifacts, etc.) should be sought to answer the questions.
4. **Recognize Multiple Perspectives and Historic Causation.** Multiple alternative perspectives must be considered. Finding polar extremes or one cause for an event or one answer to the fundamental question is not sufficient.
5. **Create Plausible Narratives.** Opportunities to construct historical narratives that explain an event or answer fundamental questions utilizing the spectrum of sources, while noting where gaps in the sources or the author’s knowledge exist.
6. **Assess Skills, Knowledge and Attitudes.** Consider assess plausible narratives utilizing (a) performance or product checklists, or (b) an analytic or holistic portfolio assessment rubric.
7. **Reflect on Experience.** Ask students to reflect on and share their experiences, identifying areas for future learning and investigation.
Adaptive Instructional Design  
(Schwartz, Lin, Brophy & Bransford, 1992)

The primary goal of this theory is to teach a deep understanding of disciplines, while simultaneously fostering the skills of problem-solving, collaboration and communication, through the use of problem-based learning, followed by more open-ended project based learning.

1. **Look Ahead and Reflect Back**
   1.1 Provides an understanding of the goals, context and challenges
   1.2 Provides an opportunity to try it right now (pretest)
   1.3 Consists of motivational series of images, narrative, and questions
   1.4 Helps students represent a specific problem as an example of a larger set of issues

2. **Present Initial Challenge**
   2.1 Helps students develop a shared, initial mental model of what’s to be learned
   2.2 Challenge selection: Motivating, interesting, invites student-generated ideas

3. **Generate Ideas**
   3.1 Helps students make their own thinking explicit
   3.2 Helps students see what other students are thinking
   3.3 Encourages sharing of ideas
   3.4 Helps teacher assess current state of student knowledge
   3.5 Provides students with a baseline to more easily see how much they learn

4. **Present Multiple Perspectives**
   4.1 Provide a way to introduce students to vocabulary and perspectives of experts
   4.2 Allow students to compare their ideas to experts’ ideas
   4.3 Provide guidance on what students need to learn about
   4.4 Provide expertise, guidance, models of social practice in the domain
   4.5 Provide realistic standards of performance
   4.6 Indicate that multiple perspectives exist in the domain

5. **Research and Revise** (to help students explore a challenge)
   5.1 Consult resources
   5.2 Collaborate with other students
   5.3 Listen to “just-in-time” lectures
   5.4 Complete skill-building lessons
   5.5 Look at legacies left by other students
   5.6 Conduct simulations and hands-on experiments

6. **Test Your Mettle** (formative assessment)
   6.1 Multiple choice tests, checklists, essays, experiments, projects
   6.2 Feedback suggests which resources to consult to reach target

7. **Go Public**
   7.1 Present best solutions (oral, multimedia, print) and leave legacy of tips and ideas for future students
   7.2 Makes thinking visible
   7.3 Helps students learn to assess others and themselves
   7.4 Helps set standards for achievement
   7.5 Helps students learn from each other
   7.6 Motivates students to do well
Eight Events for Student Centered Learning  

Based on constructivist theories of human learning, Hirumi presents seven instructional events that occur during a course to help students construct their own meaning based on their own interests and prior knowledge structures, and to promote independent, life-long learning:

1. **Set Learning Challenge** (Authentic Problem) for class
2. **Negotiate Learning Goals and Objectives** with learners
3. **Negotiate Learning Strategy** with learners
4. Learners **Construct Knowledge**
5. **Negotiate Performance Criteria** with learners
6. **Assess Learning** (Self, Peer & Expert Assessment)
7. **Provide Feedback** (Throughout Steps 1-6)
8. **Communicate Results**

Constructivist Learning  
(Jonassen, 1992)

The primary goal of this theory is to foster problem-solving and conceptual development. It is intended for ill-defined or ill-structured domains.

1. **Select Problem**
   1.1 Problem should be interesting, relevant and engaging, to foster learner ownership
   1.2 Problem should be ill-defined or ill-structured
   1.3 Problem should be authentic (what practitioners do)
   1.4 Problem design addresses context, representation, and manipulation space
2. **Provide Related Cases or worked examples to enable case-based reasoning and enhance cognitive flexibility.**
3. **Provide Information**
   3.1 Provide learner-selectable information just-in-time
   3.2 Available information should be relevant and easily accessible
4. **Provide Cognitive Tools that scaffold required skills, including problem-representation, knowledge-modeling, performance-support, and information-gathering tools**
5. **Provide Conversation and Collaboration Tools to support discourse communities, knowledge-building communities, and/or communities of learners.**
6. **Provide Social/Contextual Support for the learning environment**

Additional Instructional Activities to Support Learning:
- Model the performance and the covert cognitive processes
- Coach the learner by providing motivational prompts, monitoring and regulating the learner’s performance, provoking reflection, or perturbing learners’ models.
- Scaffold the learner by adjusting task difficulty, restructuring the task, and/or providing alternative assessments
Teacher-Directed Approaches to Teaching and Learning

Nine Events of Instruction
(Gagne, 1974, 1977; Gagne & Medsker, 1996)

Based on information processing theories and models of human learning, Gagne posits that every unit of instruction should contain the following nine events to facilitate student learning:

1. Gain Attention
2. Inform Learners of Objective(s)
3. Stimulate Recall of Prior Knowledge
4. Present Stimulus Materials
5. Provide Learning Guidance
6. Elicit Performance
7. Provide Feedback about Performance
8. Assess Performance
9. Enhance Retention and Transfer

Five Learning Components
(Dick, Carey, & Carey, 2009)

To facilitate the instructional design process, Dick, Carey and Carey (2009) organized Gagne’s nine events of instruction into five major learning components:

1. Pre-instructional Activities prior to beginning of formal instruction, addressing three factors:
   1.1 Motivating learners
   1.2 Informing learners of the objectives
   1.3 Stimulating recall of pre-requisite skills
2. Content Presentation and Learning Guidance explains what the unit is bout by presenting information, concepts, rules, and principles to be learned in either deductive or inductive manner. Learning guidance is integrated with content presentation using cues, outlines, diagrams, models, still and motion graphics, highlights, flowcharts, examples, etc.
3. Learner Participation with feedback enhances learning by giving learners an opportunity to practice what they learned using practical exercises, scenarios, and embedded tests.
4. Assessment including entry skills tests, pretests, practice tests, and posttest presented to learners at appropriate moments before, during or after the lesson.
5. Follow-Through Activities including memory aids or job aids, parallel problem scenarios, and learner plans that help learners memorize skills and facilitate the transfer of learning to new contexts.
Direct Instruction Model  
( Joyce, Weil, & Showers, 1992 )

Based on behaviorist theories of human learning, this model is designed to facilitate learning through stimulus-response conditioning and is said to generate and sustain motivation through pacing and reinforcement.

1. **Orientation**
   1.1 Establish lesson content
   1.2 Review previous learning
   1.3 Establish lesson objectives
   1.4 Establish lesson procedures

2. **Presentation**
   2.1 Explain/demonstrate new concept or skill
   2.2 Provide visual representation of task
   2.3 Check for understanding

3. **Structured Practice**
   3.1 Lead group through practice example in lock step
   3.2 Students respond to questions
   3.3 Provide corrective feedback for errors and reinforce correct practice

4. **Guided Practice**
   4.1 Students practice semi-independently
   4.2 Circulate, monitor student practice
   4.3 Provide feedback through praise, prompt, and leave

5. **Independent Practice**
   5.1 Students practice independently at home or in class
   5.2 Provide delayed feedback

**Elements of Lesson Design**  
(Hunter, 1990)

Widely known model for preparing lesson plans taught to pre-service teachers. Often used to evaluate lesson plans prepared by practicing educators.

1. **Anticipatory Set** – How will students’ attention be focused?
2. **Objective and Purpose** – What will students learn and why?
3. **Input** – What new information will be discussed?
4. **Modeling** – How can teacher illustrate new skill or content?
5. **Check for Understanding** – How can teacher determine if students are learning?
6. **Guided Practice** – What opportunities are given to practice new materials?
7. **Independent Practice** – How can assignments be used for retention and transfer?
Caine and Caine conclude that, “Optimizing the use of the human brain means using the brain’s infinite capacity to make connections—and understanding what conditions maximize this process” (Caine & Caine, 1997). They identify three interactive and mutually supportive conditions that should be present in order for complex learning to occur. By addressing 12 principles of natural learning, educators may establish the three conditions that are believed to be fundamental to complex learning.

1. **Relaxed Alertness.** An optimal state of mind that we call relaxed alertness, consisting of low threat and high challenge.
   a. Learning is enhanced by challenge and inhibited by threat
   b. The brain/mind is social
   c. The search for meaning is innate
   d. Emotions are critical to patterning

2. **Orchestrated Immersion.** The *orchestrated immersion* of the learner in multiple, complex, authentic experience.
   a. The brain/mind processes parts and wholes simultaneously
   b. All learning engages the physiology
   c. The search for meaning occurs through patterning
   d. Learning is developmental

3. **Active Processing.** The regular, *active processing* of experience as the basis for making meaning.
   a. Two approaches to memory: To store isolated facts, skills, and procedures; To make sense of experience.
   b. Learning involves both focused attention and peripheral perception.
   c. Learning is both conscious and unconscious.
   d. Each brain is uniquely organized.

Jensen posits 10 brain-based principles that he views are most important to learning. He notes that another person might come up with a different list and still be correct and that everyone neither agrees on these principles nor on the brain-based learning strategies that can be inferred from the principles. However, these are the principles that drive Jensen’s work.

1. **Malleable memories.** Memories are often not encoded at all, encoded poorly, changed or not retrieved. Memories are susceptible to inattention, erosion over time, subject bias, misattribution and a host of other confounding conditions. Memories are strengthened by frequency, intensity and practice under varying conditions and contexts.

2. **Non-conscious experience runs automatic behaviors.** The complexity of the human body requires that we automate many behaviors. The more we automate, the less we are aware of them. Most of our behaviors have come from either “undisputed downloads” from our environment or repeated behaviors that have become automatic. This suggests potential problems and opportunities in learning.

3. **Reward and addiction dependency.** Humans have a natural craving for positive feelings, including novelty, fun, reward and personal relationships. There is a natural instinct to limit pain even if it means compromising our integrity. For complex learning to occur, students need to defer gratification and develop the capability to go without an immediate reward.

4. **Attentional Limitations.** Most people cannot pay attention very long, except during flow states, because they cannot hold much information in their short-term memory. We are born with the capacity to orient and fixate attention when it comes to contrast, movement, emotions or survival. Adapting the content to match the learner provides better attention and motivation to learn.

5. **Brain seeks and creates understanding.** The human brain is a meaning-maker and meaning seeker. We assign value and meaning to many everyday occurrences whether it’s on intentional or not. Meaning-making is an important human attribute that allows us to predict and cope with experiences. The more important the meaning, the greater the attention one must pay in order to influence the content of the meaning.

6. **Rough Drafts/Gist Learning.** Brains rarely get complex learning right the first time. Instead they often sacrifice accuracy for simply developing a “rough draft” of the learning material. If, over time, the learning material maintains or increases in its importance and relevance, the brain will upgrade the rough draft to improve meaning and accuracy. To this end, prior knowledge changes how the brain organizes new information. Goal-driven learning proceeds more rapidly than random learning. Learning is enhanced by brain mechanisms with contrasting output and input goals.
7. **Input Limitations.** Several physical structures and processes limit one’s ability to take in continuous new learning. The “slow down” mechanisms include the working memory, the synaptic formation time for complex encoding and the hippocampus. While we can expose our brain to a great deal of information in a short time frame, the quality of that exposure is known as “priming” and is not considered in-depth learning. Schools typically try to cram as much content as possible in a day as possible. You can teach faster, but students will just forget faster.

8. **Perception influences our experience.** A person’s experience of life is highly subjective. Many studies show how people are easily influenced to change how we see and what we hear, feel, smell and taste. This subjectivity alters experience, which alters perception. When a person changes the way they perceive the world, they alter their experience. It is experience that drives change in the brain.

9. **Malleability/Neural Plasticity.** The brain changes every day and more importantly, we influence those changes. New areas of brain plasticity and overall malleability are regularly discovered. It is known that experience can drive physical changes in the sensory cortex, frontal lobes, temporal lobes, amygdala and hippocampus. In addition whole systems can adapt to experience such as the reward system or stress response system.

10. **Emotional-Physical State Dependency.** Nearly every type of learning includes a “go” or “no go” command to the brain in our neural net signaling process. These complex signals are comprised of excite or suppress signals. Emotions can provide the brain’s signals to either move ahead or not. Thus, learning occurs through a complex set of continuous signals which inform your brain about whether to form a memory or not. Both emotional and bodily states influence our attention, memory, learning, meaning and behavior through these signaling systems.

---

**Interplay Strategy**  
(Stapleton & Hirumi, 2011; Hirumi, Atkinson, & Stapleton, 2011)

Based on the belief that the learning of facts, concepts and principles occurs best in context of how they will be used, the Interplay strategy evokes emotions and sparks imagination, based on cognitive neuroscience research, to enhance experiential learning theories by addressing three primary conventions of interactive entertainment and their related elements (i.e., Story - characters, events, worlds; Game – rules, tools, goals; Play – stimulus, response, consequences).

1. **Expose** – Exposure provides the back-story to entice empathy for the character or player, and orients the audience into the same reference point or point of view. Exposure sets up specified learning objectives in a meaningful way to invite the student to contribute, to engage and to achieve the challenges set before them.

2. **Inquire** – Inquiry validates Exposure. If exposure sets a desire to learn, then inquiry is automatic. Inquire provides a response to student’s curiosity with something to do that showcases different elements that will be used later.

3. **Discover** – Discovery provides the personal reward, achievement, and the “ah ha” moment. The consequences of discovery, whether negative or positive, provide feedback to inspire further exploration to the next level of achievement.

4. **Create** – Transforms the experience from being merely reactive to truly interactive. Instead of responding to cues, the learner contributes to the content by applying the elements of the subject matter in novel ways.

5. **Experiment** – Provides an opportunity to assess learning and provide feedback without losing or winning. The goal is less about the hypothesis being right or wrong, but rather setting up the elements of the subject matter so that new knowledge can be gained. Failure should be fun.

6. **Share** – The sharing of personal experiences and feelings is facilitated at the end of the lesson or unit, to seal the memory of the learning experience. Sharing compels learners to put lessons learned in their own perspective as well as others.
### Alternative Approaches to Teaching and Learning

#### 4Mat System Model
*(McCarthy, 1987)*
Based on research and literature on learning styles, this eight-step cycle of instruction is meant to capitalize on students’ learning styles and brain dominance processing strengths. Rather than focus on one learning style, this method encourages students to examine and experience all learning styles.

1. **Create** an experience
2. **Reflect/Analyze** Experience
3. **Integrate** reflective analysis into concepts
4. **Develop** concepts/skills
5. **Practice** defined “givens”
6. **Practice** adding something of oneself
7. **Analyze** application for relevance, usefulness
8. **Apply** to new more complex experience

#### SQR Model
*(Maier, 1990)*
This strategy is designed to encourage students’ to take responsibility for their learning and to give students a way to generate their own ideas. In general, this strategy is geared toward enhancing student learning from reading, but may be applied in other context.

1. **Summarize**
   1.1 Read materials
   1.2 Write a summary of the materials in journal
2. **Question**
   2.1 Write question on the materials in journal
   2.2 Discuss summaries and questions in small group
   2.3 Select “best” question to share with whole class based on ability to provoke engaging discussions
   2.4 Discuss “best” questions with whole class utilizing questioning techniques
3. **Response** - Write a response to the small group or whole group class discussion (summary of main points)

#### SQ3R Study Strategy
*(Robinson, 1961)*
This strategy is designed to help students develop their study skills, particularly in relation to reading assignments.

1. **Survey** - Readers preview materials to develop general outline for organizing information.
2. **Question** - Reader raises questions with expectation of finding answers in materials
3. **Read** - Reader attempts to answer questions by reading
4. **Recite** - Reader answers questions out loud or in writing
5. **Review** - Reader rereads portions of materials to verify answers given during previous step
References


## Instructional Events Grounded in Research & Theory

Table 2. Grounded instructional events correlated to the achievement of learning outcomes

<table>
<thead>
<tr>
<th>Learning Outcome</th>
<th>Grounded Events</th>
</tr>
</thead>
<tbody>
<tr>
<td><strong>Verbal Information</strong></td>
<td><strong>Associational Techniques</strong>&lt;br&gt;• <em>Mnemonics Devices</em> (&quot;FACE&quot; for “Every Good Boy Does Fine”).&lt;br&gt;• <em>Metaphors</em> (&quot;white cells attack infections like soldiers attack enemies&quot;).&lt;br&gt;• <em>Instructor or learner generated images</em> (pictures, graphs, tables and maps).&lt;br&gt;• <em>Rehearsal</em> (drill &amp; practice).&lt;br&gt;<strong>Organizational Techniques</strong>&lt;br&gt;• <em>Clustering and chunking</em> into categories (e.g., periodic table).&lt;br&gt;• <em>Expository and narrative structures</em> (e.g., chronologies, cause and effect relationships, problem solutions, comparisons and contrasts).&lt;br&gt;• <em>Graphic and advanced organizers</em> (e.g., concept tree linking new to prior knowledge).&lt;br&gt;<strong>Elaboration Techniques</strong>&lt;br&gt;• <em>Write meaningful sentences</em> (e.g., sentences using elements of periodic table).&lt;br&gt;• <em>Devise rule</em> (e.g., describe why elements are organized in rows and columns).&lt;br&gt;<strong>Feedback Techniques</strong>&lt;br&gt;• Simple correct answer feedback (Are answers complete and correct?).</td>
</tr>
</tbody>
</table>

<p>| Concepts | <strong>Inquiry Approach</strong> (e.g., exploratory or discovery learning that typically begins with a presentation of examples and non-examples of a concept).&lt;br&gt;<strong>Expository Approach</strong> (begins with explanation of a concept and its key attributes).&lt;br&gt;<strong>Attribute Isolation</strong> (points out the critical attributes of a concept).&lt;br&gt;<strong>Concept Trees</strong> (hierarchical, graphic representations of a specified concept that illustrate the concept relationship to subordinate and superordinate concepts).&lt;br&gt;<strong>Analogies</strong> (supplied by instructor or generated by learners)&lt;br&gt;<strong>Mnemonics</strong> (when verbal information is important to concept learning or for helping learners remember the key attributes of a concept)&lt;br&gt;<strong>Imagery</strong> (a mental image of concrete concepts, such as pictures, graphs, tables and maps presented by the instruction or generated by learners).&lt;br&gt;<strong>Feedback</strong> (explanatory feedback describing why an instance is classified as an example or non-example, or why learners over or undergeneralize concepts, delayed after learner responds to several instances to discern patterns). |</p>
<table>
<thead>
<tr>
<th>Rules</th>
<th>Procedural Rules (Procedures)</th>
</tr>
</thead>
<tbody>
<tr>
<td>Relational rules or principles and procedural rules or procedures</td>
<td>• Learn to <strong>determine if/when procedure is required</strong>. Provide correct answer feedback with learner controlled explanatory feedback.</td>
</tr>
<tr>
<td></td>
<td>• Learn to <strong>list the steps in a procedure</strong>.</td>
</tr>
<tr>
<td></td>
<td>• Learn to <strong>complete the steps in a procedure</strong>.</td>
</tr>
<tr>
<td></td>
<td>• Learn to <strong>elaborate sequence</strong>, starting with simple epitome of rule and elaborating to more complex versions of same rule.</td>
</tr>
<tr>
<td></td>
<td>• Learn to <strong>check appropriateness of completed procedure</strong>.</td>
</tr>
<tr>
<td>Relational Rules (Principles)</td>
<td>• Ask learners to create their own mnemonic device(s) to support principle</td>
</tr>
<tr>
<td></td>
<td>• Ask learners to create <em>images/diagrams</em> that illustrate relationships of concepts as presented in the principle</td>
</tr>
<tr>
<td></td>
<td>• Practice stating principle (in own words).</td>
</tr>
<tr>
<td></td>
<td>• Practice recognizing situations where principle is applicable.</td>
</tr>
<tr>
<td></td>
<td>• Practice applying principle to predict, explain, or control for effects of one concept on another.</td>
</tr>
<tr>
<td></td>
<td>• Practice determining if principle was applied correctly.</td>
</tr>
</tbody>
</table>

| Problem Solving                                                      | • **Presentation of the Problem** (case studies, simulations, limiting the number of rules–principles and procedures–that must be used, presenting explicit representations of necessary rules as cues, providing solutions to parts of the problem, limiting the amount of extraneous information). |
|                                                                      | • **Problem Space** (Review directions and identify relevant information about goal state; Delineate and analyze relationship between current and goal states; Discern patterns; Define what is known and unknown about the problem and determine what information must be acquired to solve the problem; Break down the problem into intermediate states or subgoals). |
|                                                                      | • **Appropriate Principles** (guided questions–generative approach–or direct statements–supplantive approach–on how to select and apply appropriate principles and procedures to move from the given state, through intermediate states, to the goal state. |
|                                                                      | • **Practice** (Present multiple representations of the problem; Recommend techniques for limiting alternative approaches to problem resolution; Provide clues about the general form of the solution; Recommend search strategies for acquiring relevant information; Outline generic approaches for problem resolution such as hypothesis testing and working backwards; Establish criteria for evaluating the appropriateness of alternative solutions). |
**Cognitive Strategies**

Internally organized skills used to regulate and monitor the use of concepts and rules. Includes cognitive and affective domain (support) strategies.

- *Discovery and Guided Discovery* (involves more direct instruction than discovery, helping learners ascertain particular strategies through the application of questioning strategies).
- *Observation* (observe a model demonstrating the use of the strategy by paired, cooperative learners, expert demonstration; and symbolic visual or textual representation by fictional character)
- *Guided Participation* (instructor works with learners to determine characteristics of learning task, identify strategies to facilitate the task, and determine effective methods for employing the strategy)
- *Direct Instruction* (identify utility of the strategy; Provide overview of steps and their relation to overall strategy; Demonstrate or model the strategy; Illustrate examples and non-examples of strategy use; Practice application of the strategy across gradually more difficult situations; Provide corrective feedback; Encourage and guide transfer of strategy to separate but appropriate context).
- *Dyadic instruction*
- *Self-instruction*

**Attitudes**

Choice behaviors that make certain classes of action more or less probable

- *Demonstrate* desired behaviors representative of target attitude by a respected role.
- *Practice* desired behavior associated with the desired attitude is another powerful tool in attitude formation and change (e.g., role playing and group discussions)
- *Provide reinforcement* for the desired behavior (a stimulus that increases the probability of the preceding behavior reoccurring.
- *Communicate persuasive messages* from highly credible sources
- *Create dissonance* (persuading learner to perform an important behavior that is counter–dissonant–to the person own attitude, attitude change may result.

**Psychomotor Skills**

Coordinated muscular movements that may be difficult to distinguish from intellectual skills

- *Massed versus Spaced Practice* (massed practice engages learners in one or a few intensive periods of practice. Spaced practice exposes learners to short practice sessions distributed over time.
- *Whole versus Parts Practice* (whole practice is advisable if the task is simple, not meaningful in parts, made up of simultaneous performed parts and has highly dependent parts, and if the learner is able to remember long sequences, has long attention spans and is highly skilled).
- *Progressive parts practice* (if learners may have difficulties putting the parts together into a meaningful and well executed whole).
- *Backwards chaining* (where learners are exposed to and practice the last step and work their way to the first step).

**Reference**

Standards for Assessing Critical Thinking and Reasoning

Table 3. Intellectual Standards for Assessing Critical Thinking (Elder & Paul, 2010)

- **CLARITY:** Explanation is clear and concise. Key points, thoughts and ideas can be readily identified.
- **ACCURACY:** Explanation is accurate. Supported by references to credible sources. References are also appropriate and accurate.
- **PRECISION:** Explanation is precise. Provides more than adequate details to explain key points.
- **RELEVANCE:** Explanation is relevant to topic. Statements are all clearly connected to topic.
- **DEPTH:** Explanation demonstrates significant effort and depth of thought. Deals with the complexities of the issue and recognizes multiple perspectives.
- **BREADTH:** Explanation demonstrates significant effort and breadth of ideas. Addresses a variety of key points directly related to topic from multiple perspectives.
- **LOGIC:** Explanation is logical. Ideas presented in rational and coherent order. Combination of thoughts supports, rather than contradicts or appears unrelated to each other.
- **FAIRNESS:** Explanation is fair. Statements consider rights and needs of others.

Table 4. Intellectual Standards for Assessing Reasoning (Paul & Elder, 1996)

- **PURPOSE:** Purpose of elaboration is clear, significant (yet achievable and realistic), and consistent throughout.
- **PROBLEM, QUESTION or OPPORTUNITY:** Formulates the problem to be solved, question to be answered or opportunity to be realized in a clear and relevant manner.
- **POINT OF VIEW:** Articulates point of view or frame of reference in fair, clear and consistent manner.
- **EMPIRICAL FOUNDATION:** Gives clear, fair, and accurate evidence and/or support for all statements.
- **CONCEPTUAL/THEORETICAL FOUNDATION:** Ideas demonstrate deep understanding and skilled application of relevant research findings, facts, concepts, principles, rules and theories.
- **ASSUMPTIONS:** Recognizes and clearly articulates assumptions about teaching and learning relevant to context in justifiable and consistent manner.
- **IMPLICATIONS:** Clearly enunciates significant, realistic, and valid implications and consequences of their elaboration in precise manner.
- **INFERENCES:** Makes clear, sound and significant inferences in reasoning in justifiable and consistent manner.

References


Copyright © 2013 Atsusi “2c” Hirumi, PhD