Instructional Design in Learning Science

by

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Instructional Design

- A systematic development of instructional specifications using learning theory to ensure the quality of instruction.
- A systematic process of translating general principles of learning and instruction into plans for instructional materials and learning activities.

Instructional Design

- A process through which an educator:
  - attempts to a achieve specific goals
  - determines best teaching methods in a specific context
  - designs materials for specific learners
  - develops instructional materials and activities; and
  - try out and evaluation of all instruction and learner activities

Basic Learning Theories

- Behaviorism
- Cognitivism
- Constructivism

Learning Theories

Behaviorism

- Based on observable changes in behavior.
- Behaviorism focuses on a new behavioral pattern being repeated until it becomes automatic.

Cognitivism

- Based on the thought process behind the behavior.
- Changes in behavior are observed, and used as indicators as to what is happening inside the learner's mind.

Constructivism

- Based on the premise that we all construct our own perspective of the world, through individual experiences and schema.
- Focuses on preparing the learner to problem solve in ambiguous situations.

What works and how we can use it?

- A behavioral approach can effectively facilitate mastery of the content of a profession (knowing what);

- Cognitive strategies are useful in teaching problem-solving tactics where defined facts and rules are applied in unfamiliar situations (knowing how); and

- Constructivist strategies are especially suited to dealing with ill-defined problems through reflection-in-action.

Instructional Strategies

Direct Instruction	Indirect Instruction	Experiential Learning	Independent Study	Interactive Instruction
• Highly teacher-directed • Providing information or developing step-by-step skills	• Student-centred	• Student-centred & activity oriented • Emphasis: the process or learning, not the product.	• Under the supervision of teachers	• Discussion & sharing
• Lecture • Explicit teaching • Drill & practice • Compare & contrast • Didactic questions • Demonstration	• Problem solving • Case studies • Inquiry • Reflective discussion • Concept mapping	• Field trips • Conducting experiments • Simulations • Games • Role-playing • Surveys	• Essays • CAI • Journals • Learninglogs • Assigned questions • Learning centres	• Debates • Brainstorming • Discussion • Think, pair, share • Cooperative learning • Tutorial groups

Instructional Models

- A model is a mental picture that helps us understand something we cannot see or experience directly.

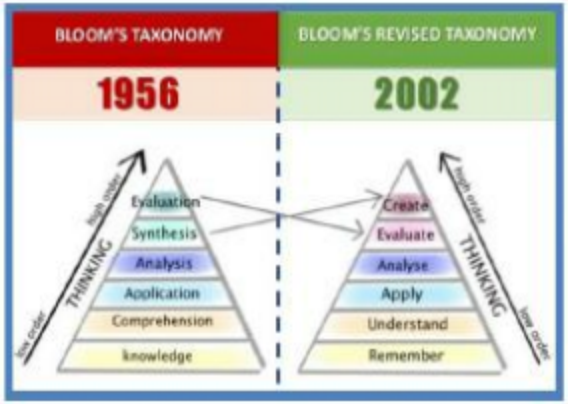
……(Dorin, Demmin & Gabel, 1990)

" Instructional Models are guidelines or sets of strategies on which the approaches to teaching by instructors are based."

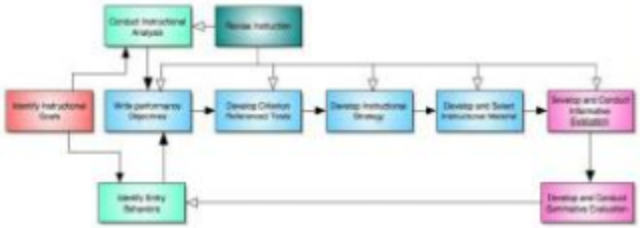
Learning technology Service, NC State University- 18:11, 18 May 2006 (MEST)]

Instructional Design Models & Methods

Bloom's Learning Taxonomy



Dick and Carey Model



Gagné's Nine Events of Instruction

Kirkpatrick's 4 Levels of Evaluation

Merrill's First Principles of Instruction

Kemp's Instructional Design Model

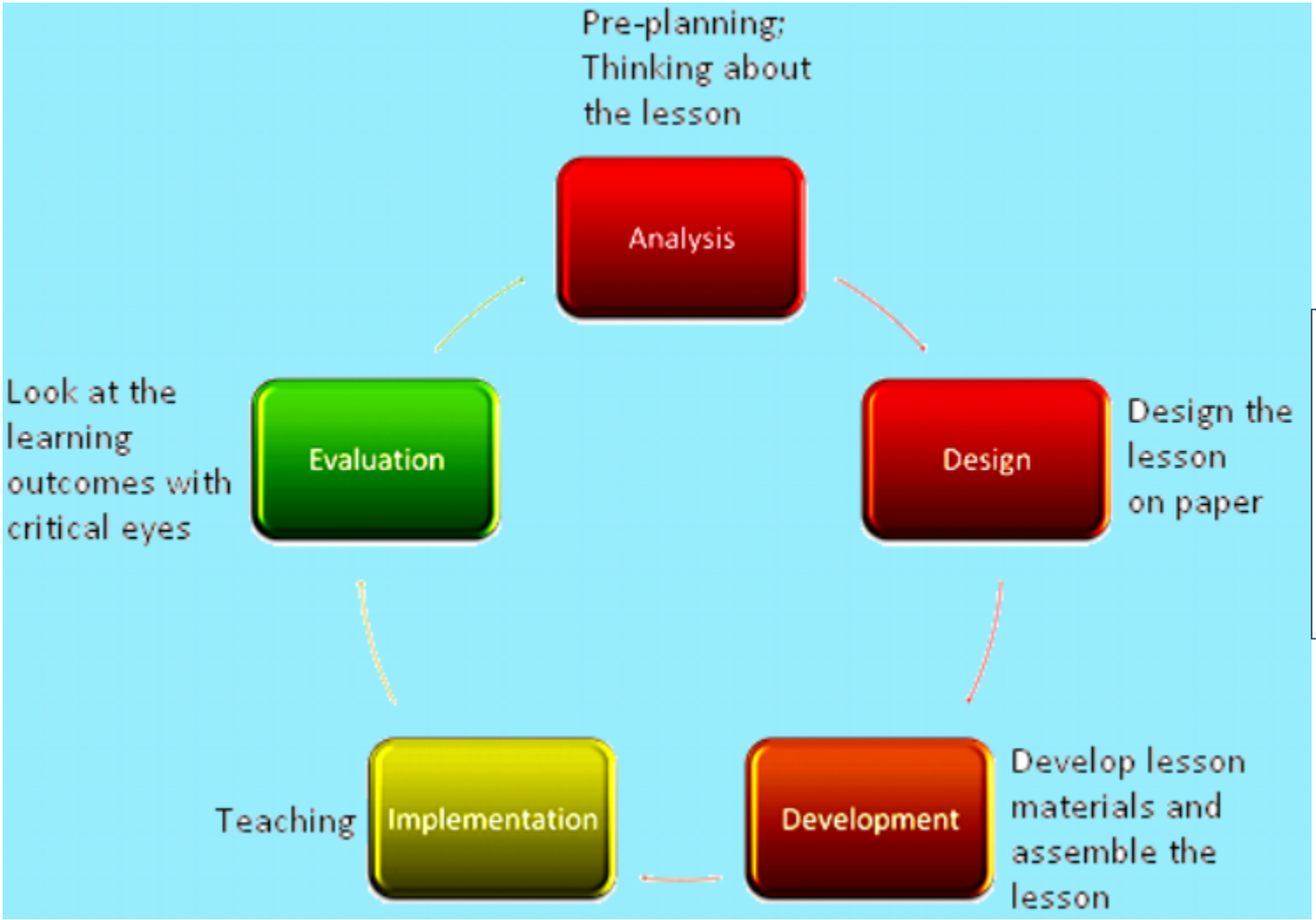
ADDIE

http://www.instructionaldesigncentral.com/htm/IDC_instructionaldesignmodels.htm

The ADDIE Model

Standard ADDIE Instructional System Design (ISD) Model

The ADDIE Model



Consider skills from 3 different objective domains:

Cognitive,

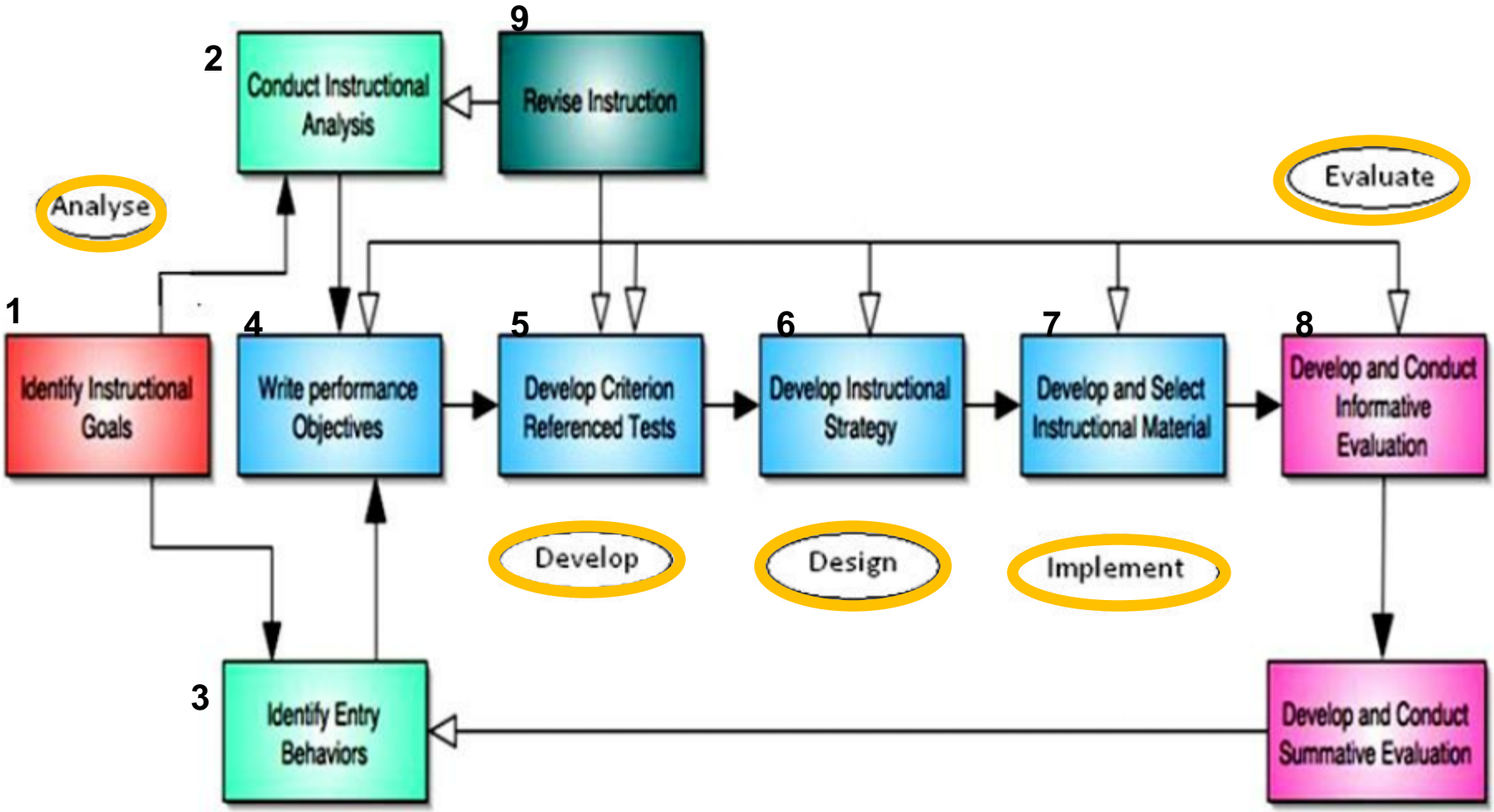
Affective,

Psychomotor

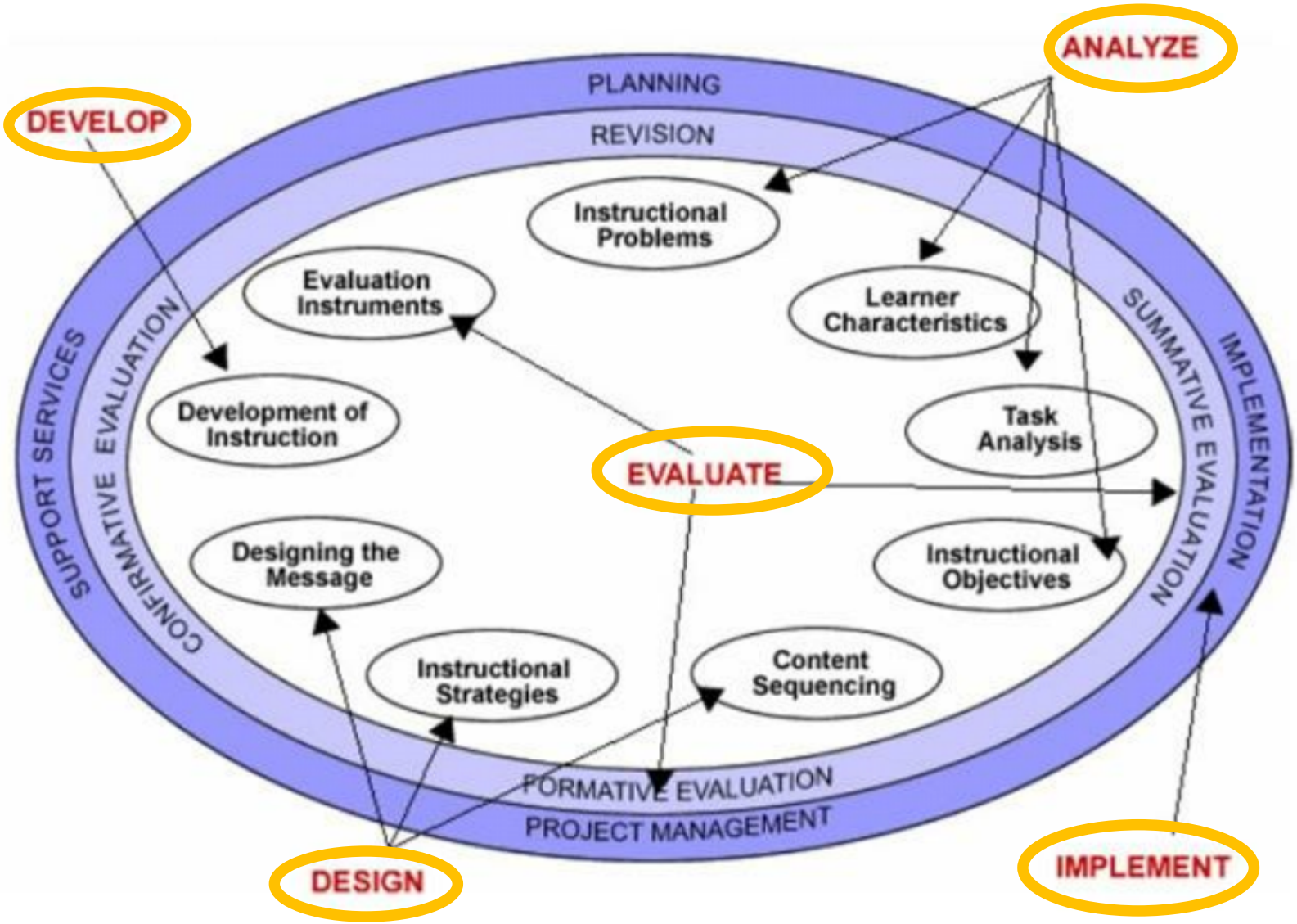
The ADDIE Model

Analyse	Design	Develop	Implement	Evaluate
Pre-planning; thinking about the lesson(s)	Design your lesson on paper	Develop instructional materials and assemble the lesson	Teaching	Look at the lesson outcomes with a critical eye
• Design of lesson • Audience • Goal • Objectives • Identify content • Identify Environment and Delivery • Instructional Strategies • Assessment Strategies • Constraints	• Name the learning units of Instruction • Identify content and strategies • Write instructions for the learning unit	• Build content, assignments, assessments • Build lesson structure	• Overview of lesson • Expectations • Initiate instruction • Interaction • Ask for feedback (formative evaluation)	• Did the students achieve expected learning outcomes? • What have you learned? • How can you make the course better?

Dick and Carey's Model



Morrison, Ross & Kemp Model



ASSURE Model

- For planning and delivering instruction that integrates technology and media into the teaching process.
  - **A**nalyse learners
  - **S**tate objectives
  - **S**elect, modify, design methods, media and materials
  - **U**tilise methods, media and materials
  - **R**equire learner participation
  - **E**valuate and revise

ARCS Model for Motivation (John Keller)

- Design the motivational aspects of learning environments to stimulate and sustain students' motivation to learn.
- Motivation is important because active learners become active and curious, which has a positive effect on their performance.
- 4 steps:

ARCS Model

ARCS Model for Motivation

1. Attention

- Capture students' interest and stimulate an attitude of inquiry.
  - Ask questions
  - Create a mental challenge
  - Use human-interest examples

2. Relevance

- Make the lesson relevant to students' needs and goals.
- Match the instruction to the learning styles and personal interest of the students.
- Tie in the instruction to the learners' experience and help them to see the relevance.

3. Confidence

- Build in students a positive expectation of success.
- Make sure that the learning experience helps students to display competence and success as a result of their efforts & abilities. It should be an achievable rather than overwhelming learning experience.

4. Satisfaction

- Encourage and support students' intrinsic enjoyment of the learning experience, as well as providing extrinsic rewarding consequences for their success.
- Also build a perception of fair treatment.
- Reinforce learning by providing useful and fair feedback.

A Constructivist Instructional Design Model

1. **Gather the content that is essential for learning.**
2. **Chunk the Material (epitomize)**

   Divide the instructional material into small units to allow better learner retention

3. **Sequence the Content into a Logical Structure**

   Present the instructional content to the learners in a manner that allows them to build upon the previous content. This is known as **scaffolding**.

A Constructivist Instructional Design Model

4. Build interest and visualisation devices

- An interest device - a story or other piece of information that captures their attention.
- Visualisation - paint a mental picture of where the learners are going.
  •Through the use of tools, such as mind maps.

5. Organise the objectives

If possible, get the learners' input for the objectives.

6. Create strategies to foster critical thinking and deeper understanding

A Constructivist Instructional Design Model

7. **Keep the learners actively involved with the learning**
   - Build activities.
8. **Build summaries and relate it to the next module of instruction**
   - Provide regular summaries. Give them time to gather their thoughts.
   - Build reflection periods for deeper understanding
9. **Test the Learners**
   - What we get tested on is what we remember the most and the longest.
10. **Help with the Transfer of Learning**

FACILITATING LEARNING: LESSON PLANNING

Pedagogical Content Knowledge (PCK)

- **A teacher's knowledge of how to help students understand specific subject matter.**
- **It also includes knowledge of how particular subject matter topics, problems, and issues can be organised, represented, and adopted for diverse interests and abilities of learners and then be presented for instruction.**

Five components of PCK

1. Orientation toward science teaching

- A way of thinking about science teaching. Types include direct/ interactive, conceptual change, discovery, project-based, inquiry, and so forth.

Five components of PCK

2. Knowledge and beliefs of science curriculum

- Being familiar with the goals for science teaching and examples of science curricula, including curriculum projects and text programs

Five components of PCK

3. Knowledge about students' understanding of specific science concepts

- Knowledge about what students bring to the class to learn new science content, and ability to identify areas of science that will probably give students great difficulty

Five components of PCK

4. Knowledge of assessment

- Being familiar with assessment standards at the local and national levels.
- Knowing how to implement a variety of assessment procedures.

Five components of PCK

5. Knowledge and beliefs about specific teaching strategies

- Being familiar with the various teaching models and specific teaching models for specific content

Designing teaching plans:

- A creative and artistic process that results in a product.
- An active, creative, and time-consuming process yet it is one that is underrated by many teachers, and indeed taken for granted as well.

Curriculum

- It is a set of intended learning outcomes or goals.
- It is what science teachers hope students will learn.
- Curriculum development, therefore, is a process in which the science teacher engages in the process of selecting and organizing learning objectives for a unit or course of study.

To summarise:

- Curriculum consists of what is to be learned;
- Instructional plan indicates how to facilitate this;
- Learning will only occur when you implement the instructional plan.

Curriculum and Instructional Design Model

Guided Questions:

1. Why? You need to consider why you are teaching the science unit, which leads to consideration of values and general science education goals and purposes.

- A rationale for a science unit, including general science education goals

Guided Questions:

2. What? Here you will consider the objectives of your unit and design a concept map to show the relationships among the major ideas of your mini unit.

- A list of objectives (intended outcomes) for a science unit, grouped according to type of student learning

Guide Questions:

3. How? The instructional plan for your mini unit– will describe how you will engage students to achieve the stated learning objectives.

- An instructional plan (a set of lesson plans) describing the unit, including intended learning objectives and the strategies you will employ to help students achieve them.

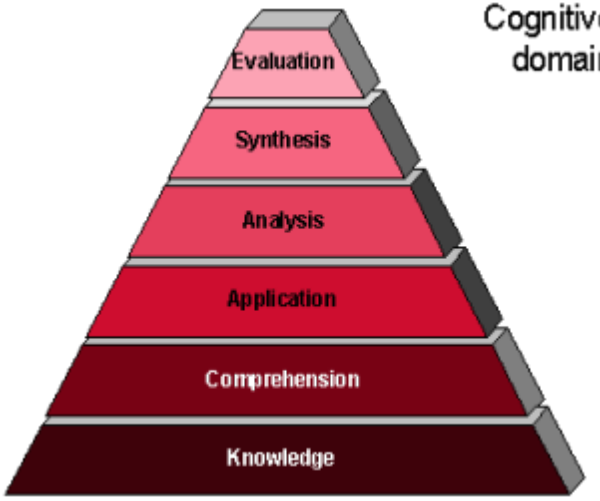
Guided Questions:

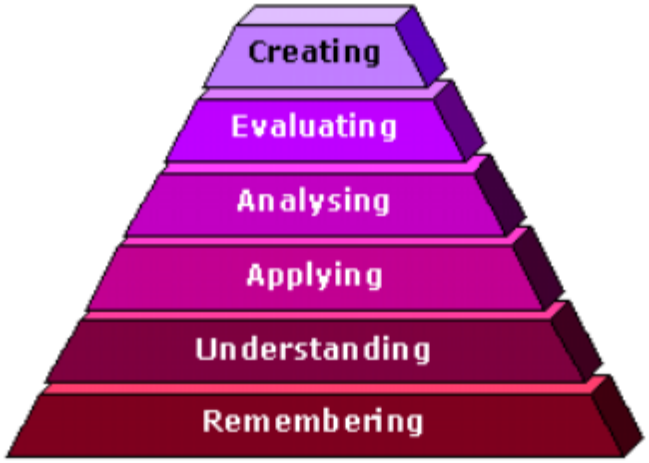
4. What did the students learn? Your evaluation plan will help you provide information about what students learned and gauge the success of your mini unit.

- An assessment plan describing the measures to assess the major objectives of the unit to provide feedback to the students and feedback for you on the effectiveness of your science unit.

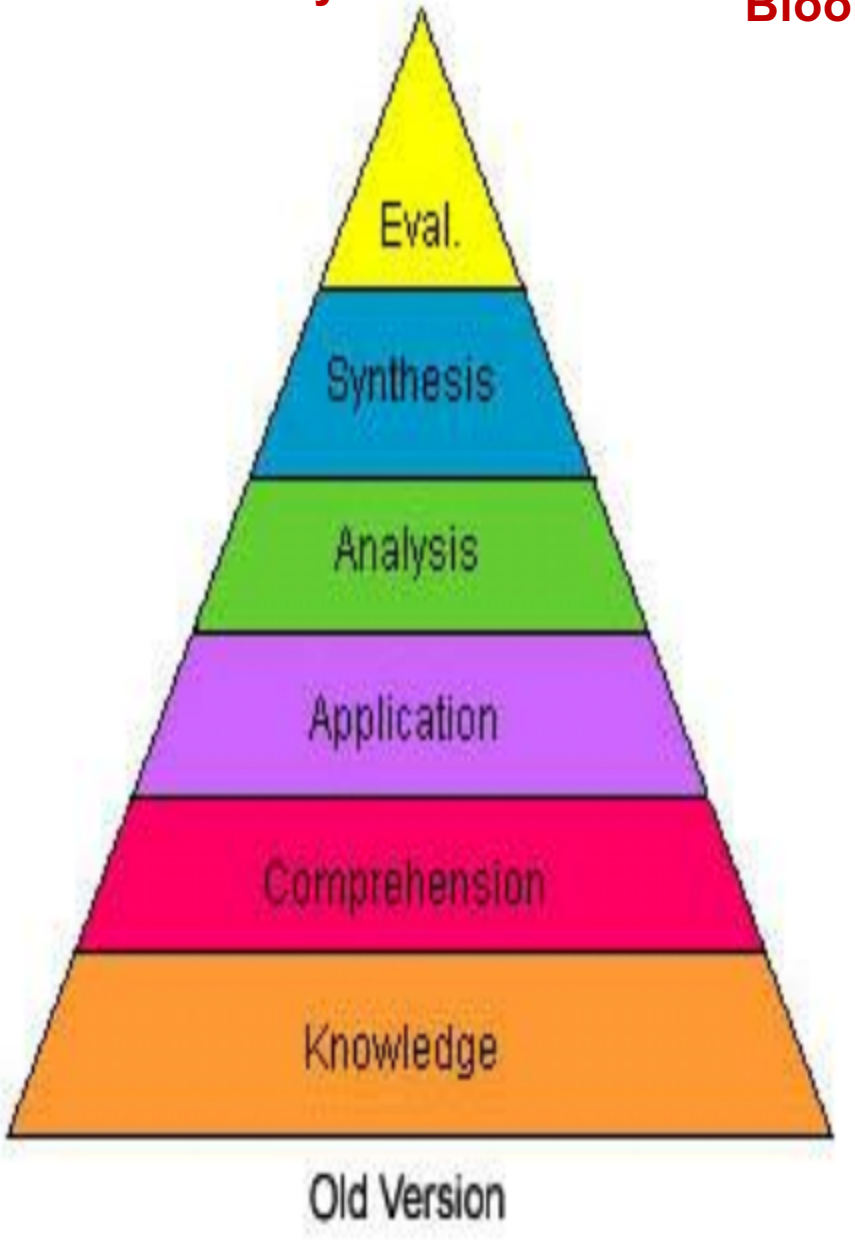
Anderson and Krathwohl's Revision of Bloom's Taxonomy

- **Model integrates cognitive models, instructional objectives, and assessments.**
- **Bloom's original work developed a framework for just the cognitive domain.**





Bloom's Taxonomy



Anderson and Krathwohl's Revision of Bloom's Taxonomy

- **Remembering**: Retrieving, recognizing, and recalling relevant knowledge from long-term memory.
- **Understanding**: Constructing meaning from oral, written, and graphic messages through interpreting, exemplifying, classifying, summarizing, inferring, comparing, and explaining.
- **Applying**: Carrying out or using a procedure through executing, or implementing.
- **Analyzing**: Breaking material into constituent parts, determining how the parts related to one another - organizing, and attributing.
- **Evaluating**: Making judgments based on criteria and standards through checking and critiquing.
- **Creating**: Putting elements together to form a coherent or functional whole; reorganizing elements into a new pattern or structure through generating, planning, or producing.

(Anderson & Krathwohl, 2001, pp. 67-68)

- **Knowledge Dimension is composed of four levels that are defined as**
  - **Factual,**
  - **Conceptual,**
  - **Procedural, and**
  - **Meta-Cognitive**
- **The Cognitive Process Dimension consists of six levels**
  - **Remember,**
  - **Understand**
  - **Apply**
  - **Analyze**
  - **Evaluate, and**
  - **Create.**

Gagne's 9 Events of Instruction

This will help you…

Gain Attention

Inform Learning Outcomes

Last class we learned how to…

Stimulate Recall of Prior Learning

Present New Content

Provide Guidance

Allow me to demonstrate

Provide Learning Activities

Now you try it…

Try it like this…

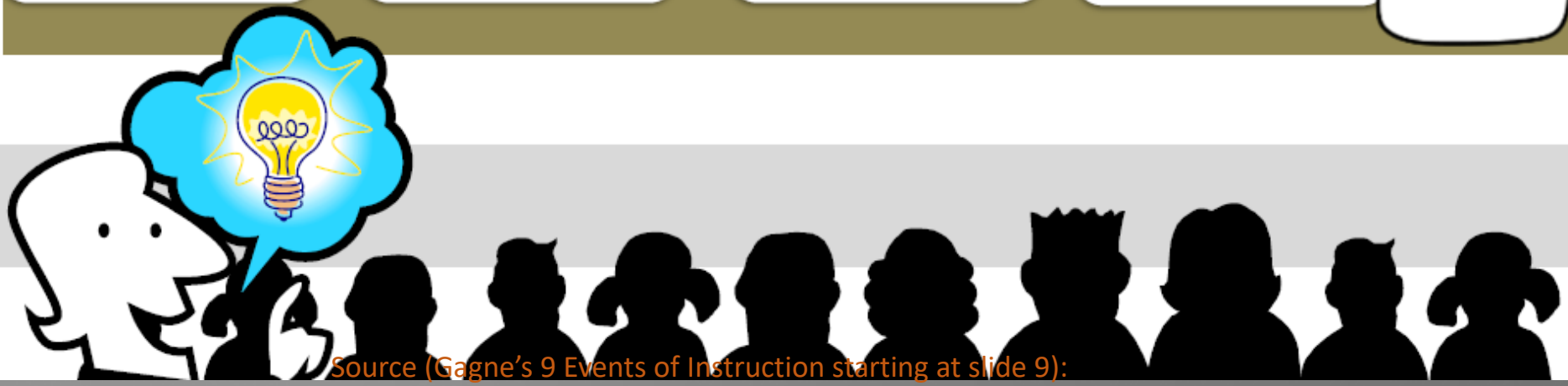
Provide Feedback

Let's test your skills now

Assess Learning

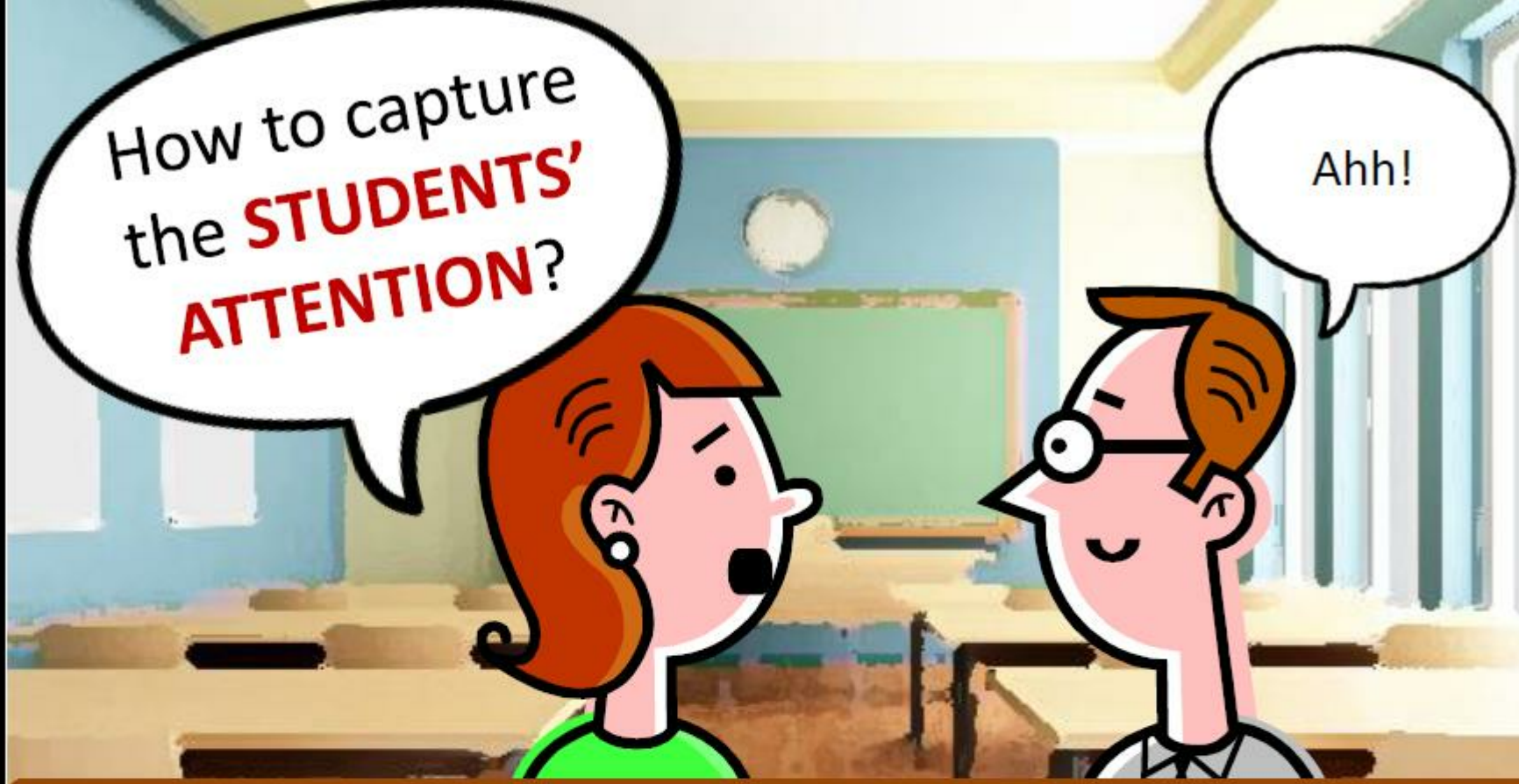
Let's do it "in the field"

Enhance Retention and Transfer



Source (Gagne's 9 Events of Instruction starting at slide 9):
http://www.slideshare.net/FareezaM/designing-engaging-presentation

Gain Attention



Question

Story

Humor

Quote

Definition

Vide Clip

Analogy

Fact

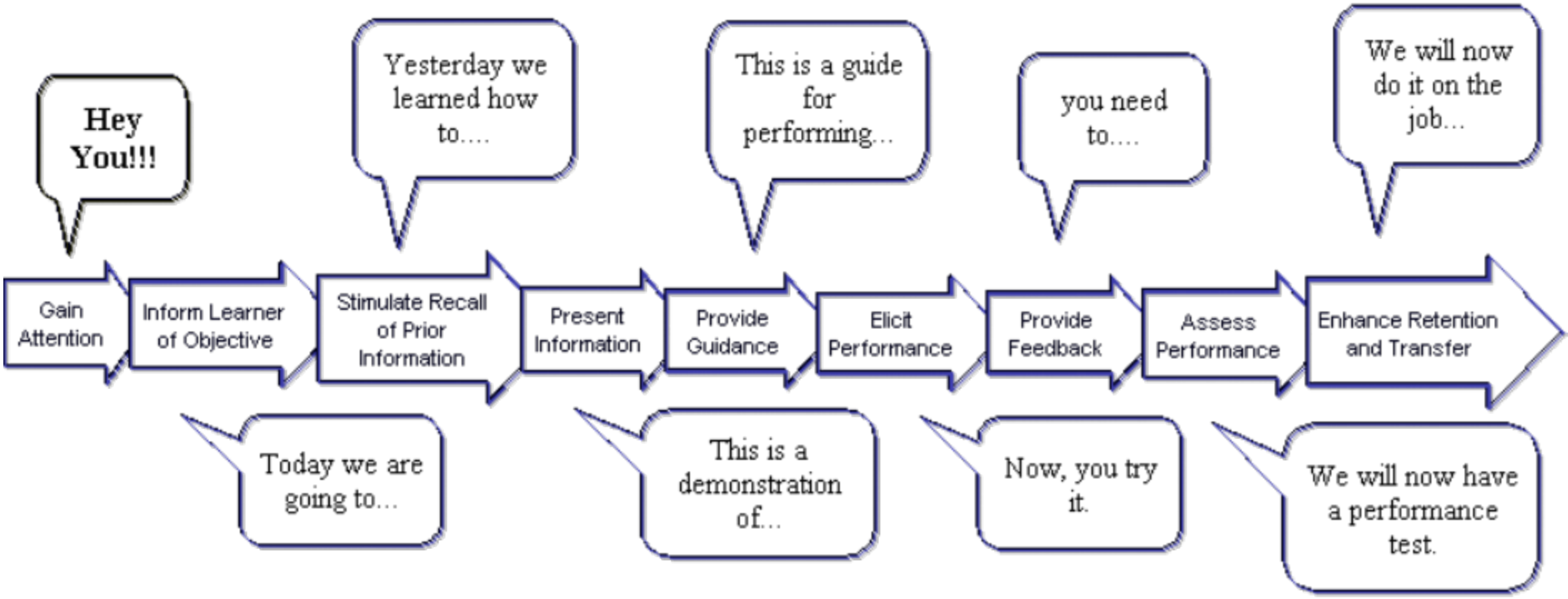
Personal experience

Demonstration

Gagne's 9 Event of Instructions

Presentation	Events of Instruction	Learning Activities
Introduction	1. Gain attention	• Present a dilemma, analogy, video
	2. Inform learning outcomes	• List clear learning outcomes creatively (Question/Challenge)
	3. Stimulate recall prior knowledge	• Explain how prior knowledge relates to new topic • Initiate discussion • Pre-tests
Content	4. Present new content	• Explanation, example, simulation
	5. Provide guidance	• Guidelines, checklists, mnemonics, group discussion
Assessment	6. Provide learning activities 7. Provide feedback 8. Assess learning	• Check your understanding • Self/Peer/Facilitator Assessment • Practical, e-Portfolio, quiz
Summary	9. Enhance retention and transfer	• Summarize/Conclude the topic • Provide additional resources

Gagne's 9 Events of Instruction: 9 Events needed for effective learning



Change

&

Make a Difference in Making Your Lesson Plan