Brahier Chapter 3

Learning Theories and Psychology in Mathematics Education

Educational Research

- Useful for informing classroom practice
- Types:
  - Quantitative vs. Qualitative
  - Experimental vs. Descriptive
- Has led to better understanding of student learning

Learning Theories in Mathematics

Has anyone ever had the experience of having a math teacher who taught the math, but did not teach the students?

Bruner's Stages of Representation

- Enactive/concrete - learning begins with an action
- Iconic/pictorial - visuals to represent the concrete situation
- Symbolic/abstract - symbolic representation of objects in experience
  - Allows organizing/relating information and concepts

The Van Hiele Model of Geometric Development

- Level 0 - visualization
- Level 1 - analysis
- Level 2 - informal deduction
- Level 3 - deduction
- Level 4 - rigor

Inquiry Approach (Constructivist Model)

- Paper-folding exercise:
  - Take a sheet of paper and fold it in half. Then take that half-sheet and fold it in half again, and again, and again. How many times can you continue to fold the paper in half before it becomes impossible to fold it again?
  - How many layers of paper do you have with different numbers of folds?
  - What patterns do you see?

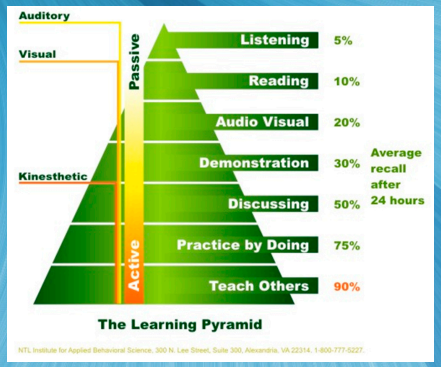
Inquiry Lesson

- Students work through an activity and develop their own math "rules" through exploration and conjecture
- Can produce deeper, longer-lasting conceptual understanding

Constructivist Model of Learning

- Based on initial work of Jean Piaget
- Knowledge cannot be passively transmitted from one person to another
- Knowledge is built/constructed from within, based on past experience and previous understanding
- Knowledge is created from *doing* and *reflecting* (*i.e.* it's an active process)

The Learning Pyramid



Work for Active Involvement!

- From very passive to very active (in order):
  - Reading, hearing words, looking at pictures, watching a movie, looking at an exhibit, watching a demonstration, seeing it done on location, participating in a discussion, giving a talk, doing a dramatic presentation, simulating the real experience, doing the real thing.

How might a constructivist classroom differ from a traditional one?

Nature of Curriculum		
Types of Activities		
Students' role		
Teachers' role		
Forms of Assessment		
Students' ways of working		

Traditional vs. Constructivist Classrooms (Brooks and Brooks, 1993)

Curriculum	Part to whole (basic skills)	Whole to part (big concepts)
Activities	Textbook driven	Real data and manipulatives
Students	Blank slates	Thinkers with model of world
Teachers' role	Transmit info	Interact, guide
Assessment	Testing	Continuous
Student work	Individual	Cooperative

Inquiry versus Deductive Teaching

- Inquiry:
  - Students think through several examples and invent/generalize rule(s)
  - TIMSS – Japanese lessons
- Deductive:
  - Teacher states rule or definition and expects students to apply to a set of exercises
  - TIMSS – US lessons

Inductive Problem Example

- The Greens are having a party. The first time the doorbell rings, 1 guest enters; on the second ring, 3 guests enter; on the third ring, 5 guests enter, and so on. That is, on each successive ring, the entering group is 2 guests larger than the preceding group. How many guests will enter on the fifteenth ring? How many total guests will be present at that time?

Circle Division

- What is the maximum number of distinct regions that can be created within a circle, based on drawing all possible line segments connecting a specified number of points placed on that circle, pairwise?

Cautionary Note!!

- Be careful about induction!
- (Consider the circle division problem.)

Concept Attainment Method

- Consider the definition of a *polygon*.
- More challenging/fun.
- Note: The goal of the math education reforms is not to make teaching easier, but to make learning easier and more meaningful.

Student Motivation

- Desire to engage in math activity
- Three components: (Ford, 1992)
  - Goal Orientation
    - Ego goal vs. Mastery goal
  - Emotions
    - Interest – personal and situational
    - Curiosity – cognitive and sensory
  - Self-confidence (self-efficacy)

Effective Teaching

- Appeals to the needs of students in a way that motivates them:
  - Move toward mastery goal orientation
  - Appeal to interests/curiosity
  - Build confidence; expand comfort zone
- Enthusiasm of teacher can "wear off" on students

Mathematical Disposition

- Important goal of NCTM Standards
- Develop mathematical learners with:
  - Confidence, flexibility, willingness, interest, curiosity
  - Value and appreciation for mathematics
  - Persistence in solving problems
- This is the opposite of *math anxiety!*