Towards Inductive Teaching and Learning

7.5.2015

Ph.D., Principal Lecturer

Jouni Enqvist
What about These Questions?

• How can ozone be both good and bad?
• How Solar Cells Work?
• How do the streetlights turn on automatically at night?
• Can we harness energy from outer space?
• How Bridges Work?
• How do trees affect the weather?

( http://www.howstuffworks.com/ )
Traditional vs. Alternative

• **Traditional teaching** (engineering, science, mathematics, …) *is deductive*, beginning with theories and progressing (maybe if there is time) to the applications of those theories.

• **Alternative teaching approaches** are more *inductive*. 
Traditional Instructor (1/2)

- Traditionally the instructor
  - introduces a topic by lecturing on general principles,
  - then uses the principles to derive mathematical models,
  - shows illustrative applications of the models,
  - gives students practice in similar derivations and applications in homework,
  - and finally tests their ability to do the same sorts of things on exams.
Traditional Instructor (2/2)

• Little or no attention is initially paid to the question of:
  – Why any of that is being done?
  – What real-world phenomena can the models explain?
  – What practical problems can they be used to solve?
  – Why should the students care about any of it?

• The only motivation that students get—if any—is that the material will be important later in the curriculum or in their careers.
When a student is strongly motivated?

- A well-established precept of educational psychology is that:

- People are most strongly motivated to learn things they clearly perceive a need to know [Albanese, M.A., and S. Mitchell, “Problem-Based Learning: A Review of Literature on its Outcomes and Implementation Issues,” Academic Medicine, Vol. 68, 1993, pp. 52–81].

- Simply telling students that they will need certain knowledge and skills some day is not a particularly effective motivator.
Inductive Teaching and Learning  (1/2)

• Instead of beginning with general principles and eventually getting to applications, the instruction begins with specifics—a set of observations or experimental data to interpret, a case study to analyze, or a complex real-world problem to solve.

(Prince & Felder 2007)
• As the students attempt to analyze the data or scenario and solve the problem, they generate a need for facts, rules, procedures, and guiding principles, at which point they are either presented with the needed information or helped to discover it for themselves. 

(Prince & Felder 2007)
Umbrella Term

- Inductive teaching and learning is an umbrella term that encompasses a range of instructional methods, including:
  - Inquiry learning,
  - Problem-based learning,
  - Project-based learning,
  - Case-based teaching,
  - Discovery learning, and
  - Just-in-time teaching.

(Prince & Felder 2007)
Common Features in these Methods (1/4)

- They are all learner-centered (also known as student-centered), meaning that they impose more responsibility on students for their own learning than the traditional lecture-based deductive approach.

Jouni Enqvist
Common Features in these Methods (2/4)

- They are all supported by research findings that students learn by fitting new information into existing cognitive structures and are unlikely to learn if the information has few apparent connections to what they already know and believe.
Common Features in these Methods (3/4)

• They can all be characterized as constructivist methods, building on the widely accepted principle that students construct their own versions of reality rather than simply absorbing versions presented by their teachers.

Jouni Enqvist
• The methods almost always involve students discussing questions and solving problems in class (active learning), with much of the work in and out of class being done by students working in groups (collaborative or cooperative learning).
Principles for Effective Instruction (1/5)

- Instruction should begin with content and experiences likely to be familiar to the students, so they can make connections to their existing knowledge structures.

- New material should be presented in the context of its intended real-world applications and its relationship to other areas of knowledge, rather than being taught abstractly and out of context.

Jouni Enqvist
Principles for Effective Instruction (2/5)

• Material should not be presented in a manner that requires students to alter their cognitive models abruptly and drastically.

• In Vygotsky’s terminology, the students should not be forced outside their “zone of proximal development,” the region between what they are capable of doing independently and what they have the potential to do under adult guidance or in collaboration with more capable peers.

Principles for Effective Instruction (3/5)

• They should also be directed to continually revisit critical concepts, improving their cognitive models with each visit.

Principles for Effective Instruction (4/5)

- Instruction should require students to fill in gaps and extrapolate material presented by the instructor.
- The goal should be to wean the students away from dependence on instructors as primary sources of required information, helping them to become self-learners.
Principles for Effective Instruction (5/5)

• Instruction should **involve students working together in small groups**.

• **This attribute**—which is considered desirable in all forms of constructivism and essential in social constructivism—supports the use of collaborative and cooperative learning.
Implication 1.

• The traditional lecture-based teaching approach is incompatible with all of these principles for effective instructions.

• The next description might serve as a definition of inductive learning:
Implication 2.

• If the constructivist model of learning is accepted—and compelling research evidence supports it—then to be effective

• instruction must set up experiences that induce students to construct knowledge for themselves, when necessary adjusting or rejecting their prior beliefs and misconceptions in light of the evidence provided by the experiences.

Jouni Enqvist