Inquiry-Based Education in Mathematics: Models, Methods, & Effectiveness for Higher Education

Dana C. Ernst, Northern Arizona University
Theron Hitchman, University of Northern Iowa

http://danaernst.com
http://www.uni.edu/theron/

Workshop on Innovations in Higher Education Mathematics Teaching
Cardiff University, 7–9 July 2014

What is IBL?

The Big Picture

If we really want students to be independent, inquisitive, & persistent, then we need to provide them with the means to acquire these skills.

What is inquiry-based learning (IBL)?

What is inquiry-based learning (IBL)?

- Hard to define! Manifests itself differently in different contexts.

What is inquiry-based learning (IBL)?

- Hard to define! Manifests itself differently in different contexts.
- According to the Academy of Inquiry-Based Learning:
  - IBL is a teaching method that engages students in sense-making activities.
  - Students are given tasks requiring them to solve problems, conjecture, experiment, explore, create, & communicate.
  - Rather than showing facts and/or algorithms, the instructor guides students via well-crafted problems.

What is inquiry-based learning (IBL)?

- Hard to define! Manifests itself differently in different contexts.
- According to the Academy of Inquiry-Based Learning:
  - IBL is a teaching method that engages students in sense-making activities.
  - Students are given tasks requiring them to solve problems, conjecture, experiment, explore, create, & communicate.
  - Rather than showing facts and/or algorithms, the instructor guides students via well-crafted problems.
- Often involves very little lecturing, and typically involves student presentations.

What is inquiry-based learning (IBL)?

- Hard to define! Manifests itself differently in different contexts.
- According to the Academy of Inquiry-Based Learning:
  - IBL is a teaching method that engages students in sense-making activities.
  - Students are given tasks requiring them to solve problems, conjecture, experiment, explore, create, & communicate.
  - Rather than showing facts and/or algorithms, the instructor guides students via well-crafted problems.
- Often involves very little lecturing, and typically involves student presentations.
- Example: Modified Moore Method, after R.L. Moore.

What is inquiry-based learning (IBL)?

- Hard to define! Manifests itself differently in different contexts.
- According to the Academy of Inquiry-Based Learning:
  - IBL is a teaching method that engages students in sense-making activities.
  - Students are given tasks requiring them to solve problems, conjecture, experiment, explore, create, & communicate.
  - Rather than showing facts and/or algorithms, the instructor guides students via well-crafted problems.
- Often involves very little lecturing, and typically involves student presentations.
- Example: Modified Moore Method, after R.L. Moore.
- Students should as much as possible be responsible for:

What is inquiry-based learning (IBL)?

- Hard to define! Manifests itself differently in different contexts.
- According to the Academy of Inquiry-Based Learning:
  - IBL is a teaching method that engages students in sense-making activities.
  - Students are given tasks requiring them to solve problems, conjecture, experiment, explore, create, & communicate.
  - Rather than showing facts and/or algorithms, the instructor guides students via well-crafted problems.
- Often involves very little lecturing, and typically involves student presentations.
- Example: Modified Moore Method, after R.L. Moore.
- Students should as much as possible be responsible for:
  - guiding the acquisition of knowledge and,
  - validating the ideas presented. (Students should not be looking to the instructor as the sole authority.)

Guiding Principle of IBL

Continually ask yourself the following question:

Guiding Principle of IBL

Continually ask yourself the following question:

> **Where do I draw the line between content I must impart to my students versus content they can produce independently?**

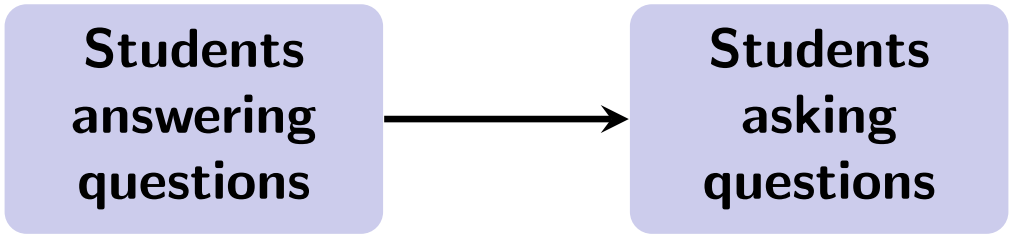
Guiding Principle of IBL

Continually ask yourself the following question:

> **Where do I draw the line between content I must impart to my students versus content they can produce independently?**

Our Main Objective

How do we get here?



Two Typical Approaches/Modes to IBL

1. Student presentations.
2. Small group work.

Most IBL instructors implement some combination.

Two Typical Approaches/Modes to IBL

1. Student presentations.
2. Small group work.

Most IBL instructors implement some combination.

Important Role Changes

- Instructor becomes a mentor, cheerleader, and coach. Focus on teaching process.
- Student becomes the mathematician.

IBL vs Presentations/Group Work

- Student presentations & group work act as vehicles for IBL.
- Yet student presentations & group do not imply IBL.
- What matters is what is happening during these activities.

IBL vs Presentations/Group Work

- Student presentations & group work act as vehicles for IBL.
- Yet student presentations & group do not imply IBL.
- What matters is what is happening during these activities.

IBL vs Inverted/Flipped Pedagogy

- IBL/Moore Method is an instructional practice.
- The flipped classroom is:
  - A platform, not an instructional practice.
  - Centered around the idea of removing some/all of the information transfer tasks outside of class & replacing the time that's freed up with whatever instructor feels is appropriate.

Are you doing IBL?

Are you doing IBL?

- Who develops the mathematics which is discussed?

Are you doing IBL?

- Who develops the mathematics which is discussed?
- Who presents the mathematics?

Are you doing IBL?

- Who develops the mathematics which is discussed?
- Who presents the mathematics?
- Who critiques the mathematics once presented?

Are you doing IBL?

- Who develops the mathematics which is discussed?
- Who presents the mathematics?
- Who critiques the mathematics once presented?
- Who decides what is correct mathematics?

Are you doing IBL?

- Who develops the mathematics which is discussed?
- Who presents the mathematics?
- Who critiques the mathematics once presented?
- Who decides what is correct mathematics?
- Who asks the questions that drive further work?