Incorporating Inquiry-Based Learning in Large Coordinated Courses: Challenges, Ideas, and Conversation

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What is a coordinated course?

- **Attempts to provide uniform quality of education by ensuring each section has consistent learning outcomes, schedule, structure, assessments, pedagogy, and grading**
- **Typically a course coordinator is assigned to decide each of these aspects of a course and manage instructors, graduate teaching assistants, and undergraduate teaching assistants to ensure consistency is maintained (mostly) across sections**
- **Typically for introductory and service courses (e.g. calculus, statistics, etc.)**
- **Sections can be taught by faculty, adjuncts, and graduate students**

Why act?

- **Address gap in perceptions of mathematics between students and instructors**
- **Reach a large number of students**
- **Develop graduate students' and instructors' pedagogy**

Course coordinator

Roles & Duties	Opportunities for Incorporating IBL
Set uniform schedule for pacing of content	Allowing some section flexibility (+/-0.5 day) and balance breadth & depth
Instructor and GTA coordination meetings	Incorporate professional development and provide materials to use
Assign homework	Turn routine exercise into inquiry, using student counter-examples, emphasize meaning
Common formal assessments	Reflect inquiry problems on formal assessments
Grading schema	Reflect IBL values in grading schemes

Incorporating professional development

Model and practice IBL strategies during coordination meetings (active meetings)

- **Question strategies**
  - **Elicit thinking, generate ideas, clarify/revise explanations, justify claims (Hallman-Thrasher & Spangler, 2020)**

- **Provide materials for instructors and graduate students to use**
  - **https://math.colorado.edu/activecalc/**
  - **https://tbil.org**
  - **https://jiblm.org/**
  - **https://activecalculus.org/ (Boelkins, Austin, Schlicker)**
  - **Desmos activities for Mulitvariable Calculus (Sparks)**

- **Professional Development Activities**
  - **College Mathematics Instructor Development Source**
  - **Video Cases for College Mathematics Instruction (Hauk, et al., 2013)**

- **Additional Resources**
  - **http://sigmaa.maa.org/ibl/**

Turning routine exercise into inquiry

Molly and Nikki are working on the following problem:

A wedge is cut out of circular cylinder of radius 4 by two planes. One plane is perpendicular to the axis of the cylinder. The other intersects the first at an angle of $30°$ *along a diameter of the cylinder. Find the volume of the wedge*

(a) Molly wants to think of the wedge as a solid of cross sections to find the volume. Explain if Molly's method will work.

(b) Nikki wants to think of the wedge as a solid of revolution to find the volume. Explain if Nikki's method will work.

(c) Find the volume of the wedge.

Dorée (2017)

Using student counterexamples

In class, Michael and Kayla were working together on the following problem in class:

$$\text{Find } \int x\sqrt[3]{3-2x}\,dx.$$

(a) Kayla says, "u should be $(3-2x)$ because I always pick the most inside factor of a function as my u."

i. Will Kayla's substitution work in this case? Explain your reasoning.

ii. Does Kayla's idea work for all u-substitutions (if it does explain, if not give an example where it does not)?

(b) Michael says the u should be $\sqrt[3]{3-2x}$ because I always pick the most complicated factor of a function as my u."

i. Will Michael's substitution work in this case? Explain your reasoning.

ii. Does Michael's idea work for all u-substitutions (if it does explain, if not give an example where it does not)?

Vinsonhaler & Lynch (2020)

Emphasize meaning

Jamie and Mike are working to understand the following problem:

A chain lying on the ground is 10 m long, and its mass is 80 kg. How much work is required to raise one end of the chain to a height of 6 m?

They went to the MARC for help, and found the solution could be found by evaluating the following integral:

$$W = 78.4 \int_0^6 (6 - x)\, dx$$

When they got home, they found they could not remember how they arrived at this solution. Help Jamie and Mike by explaining what each part of the integral represents in the context of the problem.

(a) Where did the 78.4 come from?

(b) What do the bounds represent?

(c) Where did the $(6 - x)$ come from?

(d) What does the dx represent?

(e) Why does the integral give Jamie and Mike the work required to raise one end of the chain to a height of 6 m?

Instructor

Role & Duties	Opportunities to Incorporate IBL
Teach content within a constrained schedule	Incorporate active learning activities, question strategies, make use of blend of small group and whole class discussion to control pacing
Administer formative assessments	Quiz revisions

Quiz design and opportunitiy for reflection

This week's quiz is worth a total of 10 points, the in-class portion of the quiz is worth 5 of these 10 points. The following revision assignment will be worth the other 5 points of the quiz:

- State the quiz problem that you are revising.
- Earn 1 point for explaining what was the error in your work or what concept you misunderstood in working the missed in-class quiz problem. It isn't sufficient to say, "I misread the problem." I want to know what about the problem that you misread and why that caused you problems while answering the question.
- Earn 1 point for explaining how you changed your reasoning and explaining your new approach to solving the missed in-class quiz problem. It isn't sufficient to say, "I thought about the problem different" or "the tutor told me this." I want to know how you thought about the problem differently, what your new thoughts on the problem are, and how these new thoughts help you correctly solve the problem.
- Earn 1 point for correctly answer the in-class problem
- State the quiz problem that you did not work in-class.
- Earn 1 point for explaining your reasoning and approach to solving the problem you did not work in-class
- Earn 1 point for correctly answering the problem you did not work in-class

Graduate Teaching Assistant

Role & Duties	Opportunities to Incorporate IBL
Lead recitation	Incorporate active learning activities, question strategies, student collaboration
Grading	Constructive feedback to show value in student explanation

References

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Thanks!

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