A Mathematics-Derived Perspective of Inquiry-Based Learning Usable for All Subject Areas

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About us…

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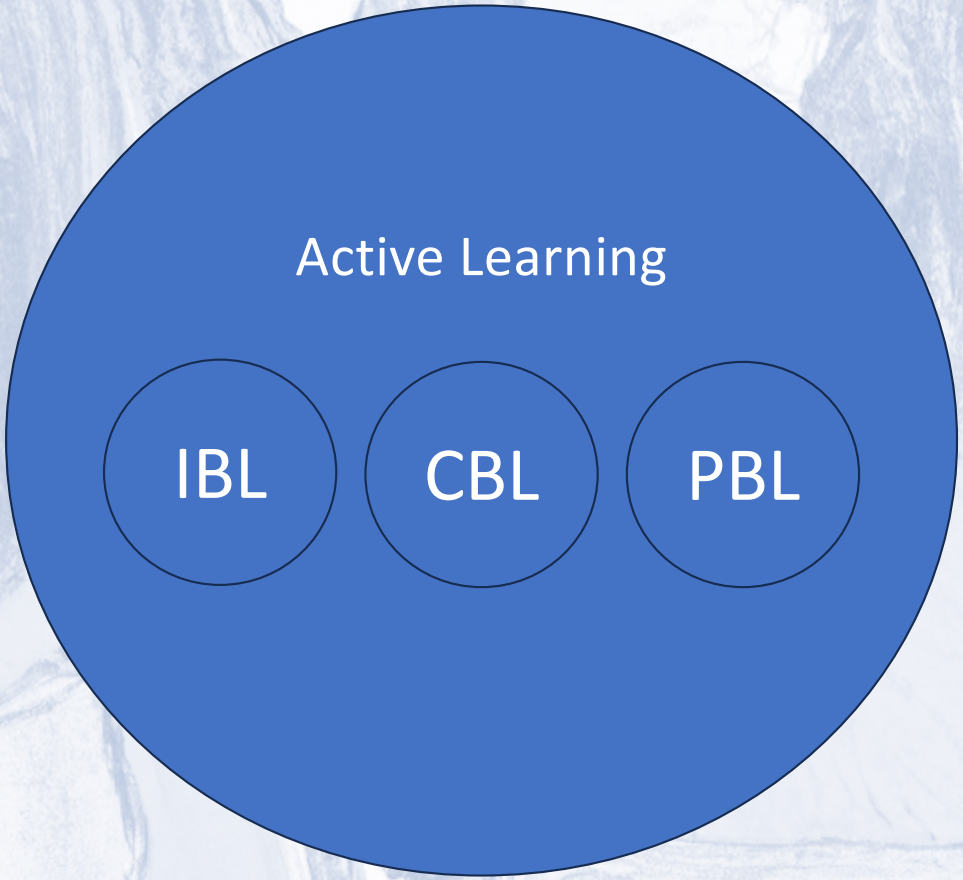
Acronyms

- IBL: Inquiry-based learning
- CBL: Case-based learning
- PBL: Problem-based learning

Similarities



- Learner-centered
- Groupwork emphasized
- Ill-structured problems

Inquiry-based learning: A form of active learning

- Students typically work collaboratively in groups
- Instructors provide learners information related to an ill-structured problem (or problem set)
- Learners engage in self-directed investigations to pursue information about the topic and come to a conclusion.
- The use of IBL allows instructors to “make students active agents in their own learning processes (Lazonder & Harmsen, 2016, p. 681).”

Inquiry-based learning in mathematics education

- Original twin pillars
  - Deep engagement in a topic
  - Opportunities for learners to collaborate in some form (Laursen et al., 2014).
- Recent (Laursen & Rasmussen, 2019) four pillars
  - Deep engagement in subject matter
  - Opportunities for collaboration
  - Inquiry into learner thinking,
  - An equitable practice for all.

Inquiry-based learning in mathematics education

Lazonder and Harmsen (2016) acknowledged there was no consistent definition of IBL.

- A meta-analysis of IBL performed by Lazonder and Harmsen (2016) allowed them to develop their own definition of IBL as a method “in which students conduct experiments, make observations or collect information in order to infer the principles underlying a topic or domain (Lazonder & Harmsen, 2016, p. 682).”
- Two main strands in IBL research were identified by Lazonder (2014)
  - Developmental differences in learners' scientific reasoning with minimal guidance
  - The effects of various types of guidance on performance success and learning outcomes.

Comparison

	PBL	CBL	IBL
Role of Instructor	Limited guidance**	Active guidance**	To sequence problems (or a set of tasks) and facilitate learning
Role of Student	Take the initiative on defining the problem, research, and solution(s)	Discussion of the provided case and possible solution(s)	To be deeply engaged in learning the content and solving the problems/tasks
Problem Type	Open-ended problems (could be a case)	Case-based problems	Sequence of problems/tasks that lead to a big idea

**Note: Some PBL and CBL characteristics taken and adapted from Hopper (2018) p. 145.

Comparison

	PBL	CBL	IBL
Learning objectives	Provided but general enough to cater to student ideas	Provided to students**	To discover new ideas and deeply understand concepts
Inquiry style	Open inquiry**	Guided or structured inquiry**	Guided with questions/tasks provided by instructor
Learning method	Self-directed**	Shared facilitator and self-directed**	Shared facilitator and self-directed
Equity*	Considered but students find their own resources to be successful	Considered but students find their own resources to be successful	An explicit element of the teaching & learning

*General equity research was found, but not within PBL and CBL literature specifically.

Comparison

	PBL	CBL	IBL
Student thinking	May or may not emerge via open discussions	Should emerge via discussions	Becomes explicit in the classroom though the learning process
Groupwork	Small groups (4-8 students)**, all with different problems and solutions	Small groups** (3-5 students), all with same problem, then bring solutions and discussion to full group	Students work collaboratively in small groups (2-4 students) then bring solutions and discussion to full group
Product	Student presentation(s)**	Wrap-up by instructor**	The sequence of problems/tasks lead to the understanding of concept, idea, or theorem.

An example of IBL in use

(1) Provide students with an assortment of triangles

(2) Have small groups of students sort the triangles any way they would like.

(3) Have the students keep track of the ways they sorted the triangles.

(4) Have a list of questions to help the students to explain how each group of students sorted the triangles.

An example of IBL in use

(5) If a group finishes early, have the group reclassify/resort the triangles in a different way.

(6) Have the full group/class share how they sorted their triangles with the class. Using vertical whiteboard space is a great way to do this.

(7) End with a full group discussion talking about why one might classify triangles and why one might classify triangles in different ways. The teacher could even have notes that students fill in the blank during this time (guided notes) while doing the full group discussion. This allows students to have their learning notes to study from at a later time.

Takeaways

- IBL, as rooted in mathematics education, distinguishes itself from PBL and CBL in its instructional approach.
- In IBL, instructors intentionally sequence tasks and problems to foster active student engagement within collaborative group settings, ultimately leading to a comprehensive understanding of significant concepts.
- We aspire for this IBL definition to extend its applicability beyond mathematics education and anticipate that our definitions and comparisons will aid both researchers and educators in their examination of teaching and learning dynamics within their classrooms.

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