Resources for Teachers and Students Transitioning Into an IBL Mathematics Course

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MOTIVATION

Inquiry-based learning (IBL) has been shown to deepen student cognitive and conceptual learning (Larsen, Hassi, Kogan & Hunter 2011; Rasmussen, Kwan, Allen, Marrongelle & Burtch 2006), as well as increase student engagement and motivation in a subject (Li, Moorman & Dyjur 2010; Brown 2004) without taking away from procedural understanding (Brickman, Gormally, Armstrong & Hallar 2009; Rasmussen et al. 2006). Through our literature review we found very few resources for instructors who are interested in applying IBL, especially for undergraduate mathematics courses. The students' experience in such a class would be sufficiently different from traditional courses; however, we could not find any resources to help college students adapt to this approach. In light of this, our study focused on addressing the need for teacher and student resources.

PURPOSE

The purpose of this study was to develop resources for undergraduate mathematics teachers and students who are transitioning to an inquiry-based learning (IBL) course. Specifically, a research-based teacher's guide to benefit an instructor who wishes to incorporate the IBL framework into one or more modules of their lower-level undergraduate mathematics class, and a corresponding student's guide designed to be given directly to students by that instructor.

STUDY DESIGN

For this study we conducted an extensive literature review that spanned not just implementation of IBL in a mathematics course but also the definitions in use for IBL, history and origins of IBL, and related teaching frameworks. Due to the limited number of resources and studies done specifically for non-proof based mathematics courses, we did not apply restrictions to our search that related to course subject matter. From the literature we were able to conceptualize IBL such that it covers a broad spectrum of teaching structures that promote student learning via inquiry.

For this study IBL is a classroom framework that focuses on student engagement and collaboration, through group work and presentations. It authentically engages students in the subject by encouraging them to participate in the exploration and creation of the mathematics they are learning in a way that realistically represents how mathematicians approach mathematics.

In tandem with reviewing the literature, we consulted with instructors who have extensive experience teaching lower level undergraduate mathematics courses and with students who have had both positive and negative experiences with IBL courses. These methods, along with our own background knowledge, helped us to determine specific aspects of an IBL course that would be most challenging for an instructor wishing to implement it for the first time or one wishing to incorporate more IBL into a course curriculum. The students' feedback and our personal perspective as undergraduate mathematics students helped us to identify aspects of the transition into an IBL course that would be most challenging for students and the relationship those challenges have to the instructors' difficulties. We used these identified key difficulties from students and instructors, our own experiences and expertise, and the available research on IBL to inform the development of a teacher's and a student's guide which address those difficulties, provide guidance for each audience, and contribute suggestions to achieve the desired learning outcomes.

RESULTS: Teacher's Guide

Setting up the Classroom

This first component details how the instructor should prepare for the class ahead of time, thinking about the type of structure and learning environment that will be used, as well as creating the proper class dynamic. When starting to incorporate the new framework, teachers will be able to refer to this section to begin designing their classroom in an IBL manner.

"the instructor should break ideas down, thinking about the connections students will be making & the depth to which those connections are mathematically accurate."

Communication

We chose this as the second component because, while it does apply to the first one, it is a crucial difference between an IBL and a lecture course. The instructor needs to facilitate proper conversations between the students and make sure that the students have genuine discussions of their ideas with each other.

"students should be talking with each other, questioning other opinions, and explaining their own"

Student Difficulties

The third component discusses specific difficulties that arise when students engage in group work and give presentations in an IBL classroom, and what teachers should be looking out for or how they can react in difficult situations. Instructors need to be aware of possible roadblocks to designing the proper learning environment.

"the new learning environment moves the responsibility of learning from the teacher to the student"

Assessments

The final component of this teacher's guide involves the role of assessment in an IBL classroom. We ask the instructor to determine how important criteria such as homework, quizzes, and presentations are to the overarching course structure, and how a student may be graded differently during the IBL section. We felt that an instructor might appreciate some suggestions on how other teachers have approached this topic, but want to leave their options open.

"teacher and student reflection – how do you tell that students took valuable knowledge out of the class?"

RESULTS: Student's Guide

An Introduction to IBL

A large part of the IBL framework emphasizes student motivation and involvement, so we felt that it was vital to include a section that is aims at persuading students to be interested and excited about this new classroom structure. This section includes a definition of IBL, what it means to inquire in the context of a mathematics course, and why students should adapt their current perspective on learning to include inquiry.

". . .class will take up more of your time than if it were a lecture class, but the experience of being in an IBL class has shown to be worth the extra effort."

Adjusting to an Environment of Inquiry

The aim of this section is to help students be productive participants in an environment of inquiry. This section encompasses three main types of environmental changes: observable changes from a traditional class, an emphasis on group work and peer interaction, and the non-traditional role of the instructor.

"…you're strongly encouraged to dive right in…. Communicating your ideas clearly and being open to discussing them with your peers will be an important way to advance your understanding"

Struggling

In this section we describe a common difficulty that students face in an IBL class and suggestions to address this difficulty. This section shows students ways of evaluating these situations to determine when it is best to move on or seek help to move forward rather than getting frustrated or falling behind.

"It is important to know what you can gain from spending time on a particular problem. You have to ask yourself where the struggle comes from and if it will lead you to conceptually deeper understanding. Do not isolate yourself. The instructor is there to help."

Following Along

This section addresses common concerns that students have with doing work outside of class: knowing "where the class is at", and assessing how they are performing in the class. Many students express anxiety about not depending on the outlined structure of a textbook when transitioning into an IBL course.

"Be aware that IBL-structured classrooms do not necessarily follow the same outline as a textbook. This does not mean that you shouldn't be encouraged to look at a textbook on your own but you should be cautious about depending too much upon it."

RESULTS: Support

Teacher's Guide: Support

Setting up the Classroom/Communication: (a) We have support encouraging strong organization prior to beginning the course; **(b)** Instructors indicated a desire to see someone's perspective who has already taught IBL, for example on what expectations to have going in.

Student Difficulties: Based on expert consultation and our team's experience, we considered a component addressing common student issues in an IBL classroom to be a useful addition in helping to navigate the classroom.

Assessments: The literature implies that many instructors have questions surrounding the role of assessments involved in an IBL classroom, so we offer suggestions that instructors can use.

All sections of the student guide are additionally supported by the research conducted to build the corresponding sections of teachers guide.

Student's Guide: Support

IBL Introduction: We could not locate research-based resources designed to motivate or persuade students to be involved in an IBL course.

Environment: We saw indications in the literature and from those we consulted that students are underprepared or unmotivated to take risks or use novel approaches to solve problems.

Struggling: (a) Students guide their own learning which can create certain issues; **(b)** Students struggle with time management because it is difficult for them to assess when too much time is being dedicated to one question.

Following Along: Our responses in this section are supported by the guidance offered by instructors and past IBL students along with our own experiences in mathematics courses.

Conclusion

This study allowed us to gather information about difficulties that teachers and students can have in an IBL classroom. Those materials helped us to create corresponding resources for both parties in such a situation. Based on our conversations with current instructors and undergraduate students, we believe that our resources will be helpful, but further research on their effectiveness in a classroom will be beneficial to advance our knowledge on these resources.

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