

What do the Calculus I Students' Have to Say About the Effect of Inquiry-Based Learning on Their Math Anxiety

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Background & Motivation

- For many years I have had an interest in math anxiety. At a national inquiry-based learning (IBL) conference in 2018, I became interested in IBL as way to reduce math anxiety.
- I have collaborated with K. Bulp, A. Hallman-Thrasher, and others, and this work has evolved into my dissertation project.
- Today, I present some findings from my dissertation research study.

Research Questions

- What were the students' experiences of learning Calculus I via inquiry-based versus lecture-based instruction?
- What were students' experiences of both instructional methods on their math anxiety?

Math Anxiety

What is math anxiety?

Math anxiety is characterized as feelings of tension and anxiety that interface with the manipulation of numbers and the solving of mathematical problems in a wide variety of ordinary life and academic situations.

(e.g., Richardson & Suinn, 1972, pp. 551)

What are its symptoms?

- **Physical:** Sweaty palms, heart racing, restlessness, nail-biting

(e.g., Ashcraft, 2002; Chang & Beilock, 2016)

- **Mental:** Intrusive thoughts, mind blanking, inability to concentrate

(e.g., Plaisance, 2009)

- **Emotional:** Apprehension, lack of confidence, extreme nervousness

(e.g., Chang & Beilock, 2016)

Four Pillars of IBL

	Mathematical Space	Social Space
Student Behavior	1. Engage deeply with meaningful tasks	2. Collaborate with classmates in processing ideas
Instructor Behavior	3. Inquire into student thinking and reasoning	4. Foster equity, respect, and responsibility

(cf. Laursen & Rasmussen, 2019; White et al., 2020)

Participant Demographics

Characteristics	IBL Group		LBI Group	
	Frequency	Percentage	Frequency	Percentage
Gender				
Male/Man	5	33%	8	40%
Female/Woman	10	67%	11	55%
Non-Binary	0	0%	1	5%
<i>Total</i>	<i>15</i>	<i>100%</i>	<i>20</i>	<i>100%</i>
Academic Standing				
Freshman	11	73%	15	75%
Sophomore	2	13%	1	5%
Junior	2	13%	4	20%
Senior	0	0%	0	0%

Data Collection and Analysis

Participant Selection

- MARS-S pre-post
Suinn & Winston (2003)
- Students whose anxiety from pre- to post-test:
 - Greatly increased
 - Greatly decreased
 - Did not change much

$$\frac{\text{IBL}}{\text{Lecture-Based}} = \frac{3}{1}$$

Data Collection

- MARS-S Survey
- Semistructured interviews
- Class observations

Data Analysis

- Nvivo software for coding
- Thematic analysis

Results

Students' Learning Experiences

<i>IBL Group</i>	<i>Lecture-Based Group</i>
<ul style="list-style-type: none"> Engaged in collaborative activities during class 	<ul style="list-style-type: none"> Initiated and maintained out-of-class collaboration
<ul style="list-style-type: none"> Instructor-student talk time ratio was (22:33)min 	<ul style="list-style-type: none"> Instructor-student talk time ratio was (53:2)min
<ul style="list-style-type: none"> Felt more welcoming and sense of belonging 	<ul style="list-style-type: none"> Felt somewhat welcoming, but no sense of belonging
<ul style="list-style-type: none"> Optional HW problems that were not graded 	<ul style="list-style-type: none"> Too many and mandatory HW problems that were graded
<ul style="list-style-type: none"> Sought for extra support from the instructor 	<ul style="list-style-type: none"> Sought for extra support from the recitation instructor
<ul style="list-style-type: none"> Felt more confident and empowered 	<ul style="list-style-type: none"> Felt moderately confident and empowered

Results (Contd.)

Activities That Reduced Students' Anxiety

IBL Group

- Blended learning environment
- In-class group activities
- Talking to their groupmates
- Welcoming and caring nature of the instructor
- Instructor's readiness to meet students in-and-out of class
- Optional and ungraded HW
- Opportunity to resubmit the tests

Lecture-Based Group

- Recitation classes
- Recorded lecture videos
- Out-of-class group work

Results (Contd.)

Activities That Increased Students' Anxiety

IBL Group

- Gradually accelerated course pace

Lecture-Based Group

- Fast paced teaching
- Too many Webwork problems

Activities That Increased Both Groups' Anxiety

- Tests and quizzes
- Proctored-track exams
- Thinking of being called on by the instructor
- Responding to the instructor's questions in front of their classmates

Student Quotes

IBL Group

I think doing the task in a group reduced it (anxiety) for sure...

I would definitely say I don't enjoy going to class because I'm scared, he's going to call on me and ask me a question I don't know the answer to.

Lecture-Based Group

In the group meet ... if they (colleagues) have questions, they just ask. And then, there would be the one person that would either respond, or they won't if it's not easy.

I was a little stressed out because he would call on people, and I was scared that he would call on me.

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Questions, Comments, & Discussions?

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