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ASSESSING THE PEDAGOGICAL CHANGE BY GRADUATE TEACHING  
ASSISTANTS NEW TO INQUIRY-BASED LEARNING

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ASSESSING THE PEDAGOGICAL CHANGE BY GRADUATE TEACHING  
ASSISTANTS NEW TO INQUIRY-BASED LEARNING

A THESIS APPROVED FOR THE  
DEPARTMENT OF MATHEMATICS

BY

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To Clark:

Your love and support are the reason I had the courage to apply and the strength to finish graduate school.

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## **Abstract**

There is a great difficulty in how graduate students acclimate to both their student and teaching requirements. Adding to that difficulty, some students are also curious about varying pedagogical techniques. This pioneering research examines the intersection of working as a graduate student, teaching in a coordinated course, and the implementation of inquiry-based learning (IBL). Inquiry-based learning has known benefits, and the amount of research on the topic is growing. However, the researcher found no previous research on the topic of creating an inquiry-based learning course that is coordinated. The idea of using IBL in a coordinated course means that more graduate students have potential to be exposed to different ways of teaching. This study follows three participants that had all taught at the university level previously but were new to teaching using IBL. The coordination of this course meant that class sizes were smaller, room assignments were conducive to group work, graduate students received a workbook to facilitate classroom learning, and they had the aid of an undergraduate learning assistant. Therefore, the graduate students were able to focus on the day-to-day activities in their classroom without having the cited barriers to making this pedagogical change, providing them with psychological safety. After one semester, they all agreed that they would continue using active learning more frequently as they move forward as instructors, but did not acknowledge the barriers that they may face teaching a different course.

Keywords: Inquiry-based learning, Graduate Teaching Assistants, and Coordination



## **Chapter 1: Introduction**

### **1.1 Motivation**

This pioneering study was done in order to assess what it looks like to make the pedagogical change to inquiry-based learning (IBL) under the confines of a coordinated class. There is a plethora of research about the benefits of IBL (e.g., Laursen et al., 2014) as well as the reasons that instructors are hesitant to make the change to IBL (e.g., Henderson and Dancy, 2007). The nature of a coordinated course takes many of the commonly cited barriers out of the equation such as content coverage, class size, and departmental norms, but also introduces some unique challenges such as a semi-strict schedule with strict content goals. The characteristics of IBL and coordination create a dichotomy due to the strict nature of coordinated courses as compared to the more fluid approach of IBL. The strict nature of a coordinated course may provide the instructors with a sense of psychological safety or comfort to change pedagogies without loss of their identity.

### **1.2 Research Question**

What are the factors that provide psychological safety for graduate students to make the change to inquiry-based learning, specifically in a coordinated course?

## **Chapter 2: Background Literature**

### **2.1 Inquiry-Based Learning**

Inquiry-based learning (IBL) is defined by Hayward and Laursen (2016) as “a form of active, student-centered instruction in mathematics that helps students develop critical thinking through exploring loosely-structured problems and by constructing and evaluating mathematical arguments” (p. 60). IBL may create a classroom where “students do mathematics like research mathematicians do mathematics” (Yoshinobu,

2012, p. 307). This is in contrast to “traditional lecture method,” which is commonly where an instructor is a “dispenser of knowledge” and the students are “passive consumers of knowledge” (Yoshinobu, 2012, p. 304). While this is not a definition of lecturing in general (e.g., Weber, 2004), one can make a hardline distinction: in a lecture-based course, less than half of the time in class is spent on student-centered activities (Laursen, Hassi, Kogan, & Weston, 2014).

There is a growing body of literature to support the pedagogical change from a lecture style to using IBL techniques. For example, Laursen et al. (2014), in a large national study on IBL, concluded that,

Students in IBL math-track courses reported greater learning gains than their non-IBL peers on every measure: cognitive gains in understanding and thinking; affective gains in confidence, persistence, and positive attitude about mathematics; and collaborative gains in working with others, seeking help, and appreciating different perspectives. (p. 409)

In fact, Freeman et al. (2014) stated that the benefits of IBL are so strong that,

If the experiments analyzed here had been conducted as randomized controlled trials of medical interventions, they may have been stopped for benefit - meaning that enrolling patients in the control condition might be discontinued because the treatment being tested was clearly more beneficial. (p. 8413)

Even without these benefits, it is conjectured that IBL is what will support long-term success for students due to the way that the world is changing: “In the Google age of information, knowledge, as an end in itself, has become less important, while the value of processing and evaluating information and solving problems has increased.”

(Yoshinobu, 2012, p. 313)

However, the benefits listed above are not necessarily enough to change the mind of all instructors. There are many documented barriers to making the change to more active teaching. Henderson and Dancy (2007) interviewed instructors at the

collegiate level to identify specific reasons that instructors were unwilling or apprehensive to change their teaching style. The researchers concluded that “the most salient barriers” are:

- 1) Student attitude toward school
- 2) Expectations of content coverage
- 3) Lack of instructor time
- 4) Departmental norms
- 5) Student resistance
- 6) Class size and room layout
- 7) Time structure (Henderson & Dancy, 2007, p. 9)

With the pedagogical change to inquiry-based learning in general, instructors may see the cost as outweighing the benefits and thus not be motivated to change.

There is research devoted to the stages that instructors must go through if and when they change to IBL. These stages were originally introduced by K. Patricia Cross at a national conference in an effort to improve college teaching and have been used by multiple authors since then (e.g. Paulsen and Feldman, 1995). First, there is the ‘unfreezing’ stage where “instructors gain the motivation to change” (Heyward and Laursen, 2016, p. 1). Key to this stage is “psychological safety” through “envisioning ways to change that will produce results that reestablish [the instructor’s] positive self-image without feeling any loss of integrity or identity.” (p. 2) The second stage is ‘changing’ where instructors begin to apply the new teaching technique. The final stage is when the instructor either decides to continue using the new method or to return to their previous teaching strategies, which is called ‘refreezing’ (p. 2). This study will observe graduate students that change their pedagogical actions as a result of teaching a coordinated course. In particular, this study will focus on their journey through the second stage since their unfreezing stage is very short.

## 2.2 Graduate Students as Teaching Assistants

### 2.2.1 *The Role of Teaching Assistants*

At universities with graduate programs, graduate students are often offered jobs as teaching assistants (TAs) to help them work off the cost of their education. However, their value to a college or university is enormous. Speer, Gutmann, and Murphy (2005) stated:

TAs often have significant responsibility for teaching lower-division courses, including courses for mathematics majors, client department service courses (such as engineering calculus), content courses for prospective K-12 teachers, and courses intended to meet the general mathematics needs of an educated citizenry (such as finite mathematics and quantitative reasoning). (p. 76)

While many TAs aspire to be professors at the University level, they may not see their current level of importance in their mathematics department. For all intents and purposes, they are the role models for the students that they teach, and they are the future source for mathematics faculty. Furthermore, they are shaping the future pool of graduate students with their work as undergraduate instructors. “Thus the potential influence that TAs have on undergraduate students’ experiences with mathematics is tremendous.” (Speer, Gutmann, and Murphy, 2005, p. 76)

Graduate students have to balance taking their own courses with the (often new) job as a teacher. “The TA must fulfill important responsibilities of personal study (and later, as a faculty member, responsibilities of scholarship and service as well)” (Speer, Gutmann, and Murphy, 2005, p. 79). This is a unique situation compared to a preservice or in-service teacher, who “sees teaching as her primary job responsibility” (ibid, p. 79).

A TA’s instruction style is often defined by their own experiences as mathematics students. They also may feel pressure to conform and adjust to a perceived common method of teaching within the mathematics department where they are

students. “To succeed, they need, or at least believe they need to adopt the habits and attitudes of their faculty mentors. Pressures to become part of the existing culture are strong” (Speer, Gutmann, and Murphy, 2005, p. 78). TAs are valuable to their departments, but they must balance teaching and school while also adhering to departmental norms. This large amount of responsibility may be the reason that TAs are often assigned to coordinated courses because some aspects of coordinated courses can allow the TA to focus on other responsibilities.

### *2.2.2 The Role of Coordinated Courses*

To support graduate students in their beginning stages of teaching, they are often given a course that is coordinated by a full-time faculty member. Coordinated courses often come with common syllabi and common assessments. This means that the graduate students can focus on the day-to-day activities within their classroom and that the graduate students teaching these courses have fewer responsibilities than the average instructor. However, coordinated courses do not always lead to the best teaching environment. DeFranco and McGivney-Burelle (2001) found that

all of the TAs were expected to follow demanding and rigid common course syllabi, which were designed by senior faculty members in the mathematics department. As a result, many of the TAs’ viewed teaching as “covering the material” rather than promoting student understanding. (p. 8)

When the issue of student understanding is brought up, TAs have a perceived sense of success determined by the specific tasks and specific goals laid in front of them. “A TA’s ability to keep up with common course syllabi and prepare their students for the common exams was viewed by the TAs as evidence that they were being effective teachers” (p. 9) Their perceived success may have prevented “the TAs from

becoming dissatisfied with their teaching” (p. 9) and therefore creating a barrier for TAs in this situation to reaching the “unfreezing” stage.

There is an issue with the gap between what the goals of a course are and what actually happens in the classroom; it is not a unique issue for TAs. Samuelowicz and Bain (1992) referred to this as “one of the mysteries of higher education-the disjunction between the stated aims (promotion of critical thinking) and educational practice (unimaginative coverage of content and testing of factual recall) of college faculty” (p. 110). In his foreword, Shulman claimed this forces a contradiction: “that on one hand, curriculum, in the form of written materials, historically manifests itself as carefully organized, concrete, rigid, and well-planned units of instruction; whereas teaching, on the other hand, is interactive, natural and unstructured” (Ben-Peretz, 1990, p. vii).

The courses taught by graduate students are often smaller in size, the content is fixed and can be adjusted by a senior faculty member, and the coordinator handles the task of creating instructional materials. The course that is examined in this paper involved using a workbook rather than strictly using a textbook. This workbook was created by a group of faculty members and graduate students specifically for the course studied in order to facilitate the change to IBL. This tool given to the instructors helps provide “ill-structured but meaningful problems. Following a carefully designed sequence of tasks rather than a textbook, students construct, analyze and critique mathematical arguments,” (Laursen et. al., 2014, p. 407) which Yoshinobu and Jones (2013) describes as one of the characteristics of an IBL classroom. Tools like a workbook help facilitate an easier transition to teaching for graduate students, and these tools are often given during professional development opportunities.

### *2.2.3 The Professional Development for Teaching Assistants*

Graduate students may be future professors, so it is important to note that they may learn their teaching practices as early as their first year of being an instructor. “The time spent as a TA is the time during which young mathematicians will develop teaching practices they will likely carry with them into their careers as faculty members” (Speer, Gutmann, and Murphy, 2005, p. 76). Therefore, as the role of teaching assistants has been noted as more important recently, the research is developing about how to better support them:

Over the past five years, educators have begun to address the issue of TAs in two ways: designing preparation and development programs that target mathematics graduate students who are or will be teaching undergraduates and by beginning research programs focusing on the TA experience. (Speer, Gutmann, and Murphy, 2005, p. 75)

These professional development programs are typically offered before the first semester of graduate studies begin and occasionally during the first semester or year of a graduate student’s study.

Professional development has been shown to change the beliefs of TAs, but that does not necessarily mean that their teaching will change as well. DeFranco and McGivney-Burelle (2001) found that “although the TAs adopted a new set of beliefs about the teaching and learning of mathematics their classroom practices remained the same” (p. 8). This is an important discovery because it underlines the need for more research on the professional development of graduate students as well to what degree support (or lack thereof) from the department influences their success as instructors. The study goes on to say that the “TAs indicated a new understanding of how students learn mathematics, [but] this belief seemed to be held peripherally and in conflict with their views about the role of teachers” (p. 8).

## **Chapter 3: Methodology**

### **3.1 Context of the Study**

#### *3.1.1 The Course*

At a “highest research activity” ranking university in Midwest, the mathematics faculty noticed a gap between students that were deemed successful in their Trigonometry (Trig) course and their success in the subsequent course, Calculus I. After significant amounts of research, a team of faculty members decided to make the switch to IBL in the Trig course. The course changed to use group work and discovery learning daily. Prince and Felder (2007) define discovery learning as “students [being] confronted with a challenge and left to work out the solution on their own. The instructor may provide feedback in response to student efforts but offers little to no direction before or during those efforts” (p. 15).

The instructors of the Trig sections were mostly graduate students in the mathematics department. They typically have taught at least one full year of a different course and sometimes have experience as calculus discussion leaders. All graduate students at this University have gone through teacher training for two weeks prior to teaching any University courses as well as a semester long class called “Teaching College Math” which explores various aspects of teaching assignments. In order to provide additional support for the instructors making this pedagogical change, the coordinator required an additional twenty-one hours of training about active learning.

The course studied is a coordinated course; there were common syllabi, common pacing, common homework, common quizzes, and common exams. This presented a unique challenge for the coordinator and the instructors due to the nature of an inquiry-based learning classroom. In order to mitigate some of the common challenges that



instructors face when trying to change their teaching style to active learning, the teaching assistants were provided with:

- less content to cover than the previous traditional-lecture trigonometry course
- smaller class sizes
- classrooms that were created for group work with whiteboard on multiple walls as well as desks and chairs that are easily moved
- they are given a workbook that provides questions for group work to facilitate discovery learning
- they work with learning assistants (LAs), an undergraduate student that help with some of the paperwork like entering grades and attendance, as well as to give another prospective to groups while they are working
- they have weekly meetings to ensure that everyone has the support that they need to feel like they can be successful. These meetings also help instructors to document things that they wish were worded differently or in a different sequencing throughout the semester in attempts to make better versions of the workbook.
- The teaching assistants also work together to grade exams through the use of Grade Scope<sup>1</sup> (a computer program used for grading).

### *3.1.2 The Participants*

For the purpose of this study, three participants were chosen who had prior teaching experience but had not previously taught a course in an IBL style. Ima, John, and Maria (pseudonyms and gender pronouns were determined by the respective participant) were all students that had listed this course as one that they would prefer to teach in the upcoming semester. Ima had the most prior teaching experience. Although she had not been in a course that exclusively used inquiry-based learning, she adopted techniques from her previous instructors to use in her own classroom to enhance lecture. John had been in one course taught using inquiry-based learning but had only taught using traditional methods. Maria had only one semester as an instructor of record but

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<sup>1</sup> Please see [https://gradescope.com/get\\_started](https://gradescope.com/get_started) for more information.

used inquiry-based instruction in calculus discussion sections because of the freedom that she felt when running that course.

The participants all had a short ‘unfreezing’ process in which they listed teaching this course as their preference, and the coordinator chose them to be instructors. The instructors then entered the “changing” phase almost immediately and began their training for their new teaching assignment. They had the desired classroom environment, class size, and a sense of structure in terms of content and scheduling due to the nature of coordinated courses.

## **3.2 Data Collection**

### *3.2.1 Techniques*

The researcher attended the training for this course, which included both graduate students that were new to this style of teaching as well as graduate students that had taught Trig in the past. Notes were taken and the sessions that were directly relevant to the pedagogical change were video recorded. The researcher was not present at any of their training over the way they would be grading. This decision was made in hopes of making an explicit effort to show the Teaching Assistants that this research would not be trying to evaluate the classroom performance of them or their students in any way.

After the training but before classes began, the researcher sat down with the three TAs individually and interviewed them about the upcoming semester. The semi-structured interviews were audio-recorded and focused on the TAs’ definitions and understandings of inquiry-based learning as well as their thoughts about the possible

challenges they would have throughout the semester. Appendix A has the list of questions used in the interviews. These interviews were then transcribed.

Throughout the semester, the researcher sat in on each participant's class roughly once a month. To create more comfort with the classroom observations, the participants determined the date that the researcher would come in. A Livescribe™ pen was used that audio recorded the class as the researcher took notes. Although this data is not explicitly used in the results, participants brought up specific instances in the interviews that the researcher had been present for and attending their class enhanced the relationship between the researcher and the participants.

After the semester ended, the researcher interviewed the three participants again. This interview asked some of the same questions as the first interview with the additional question, "What advice would you give an incoming teaching assistant about to teach this course?" The list of these questions can be found in Appendix B. These interviews were also transcribed. After that data had been collected, it seemed like the research would benefit from a follow-up with the participants. The participants were emailed a list of questions and asked to answer them at their convenience. These questions can be found in Appendix C. Their written responses were collected.

### *3.2.2 Timeline*

The timeline of the data collection events is as follows:

Early August 2017: Participants are observed throughout their training.

Mid August 2017: "Pre-Interview" participants are interviewed after training, but before their first class period.

Early September 2017: First observation of participants

Late September/Early October 2017: Second observation of participants.

Late October/Early November 2017: Third observation of participants.

Late November/Early December 2017: Fourth observation of participants.

Early December 2017: “Post-Interview” participants are interviewed after their last class period of the semester.

Late February 2018: Participants are emailed with follow-up questions.

### **3.3 Data Analysis**

The researcher went into this study with the intent to investigate the implementation of IBL. The researcher had four different research questions throughout the process due to the nature of the analysis. The responses from each interview were then open-coded which provided the researcher with the opportunity to look into the data without trying to force a particular conclusion. These open-coded interviews allowed the researcher to make connections and conclusions based on the data rather than what the researcher may have been looking for. This analysis used methods of grounded theory (Strauss & Corbin, 1994) where the overall themes in the results section were “generated initially from the data, or...matching of theory against data” (p. 273). Patterns in the data were found before determining a specific research question to answer in order to minimize bias in data interpretation.

## **Chapter 4: Results**

### **4.1 Defining Inquiry Based Learning**

When asked to define inquiry-based learning before the participants had taught the course, all of them mentioned their role in the teaching process. Ima immediately began by defining IBL with an example: “I would put a question up on the board and ...

just let them go at it.” Maria and John both used the phrase “inquiry-based teaching” when defining IBL. In the post-interview, all of the participants put the focus on what a student would experience in a class that was using inquiry-based learning. Ima said it is where “the students are supposed to come up with the tools on their own”. John stated, “Students are more in charge of what they learn.” Maria compared it explicitly to traditional lecture, saying that IBL was the opposite.

When asked to propose a ratio of student to teacher interactions in their pre-interview, all three participants stated that a strict majority of the time should be student-centered. Maria thought that students should be active roughly 70% of the time, John thought it should be closer to 80% and Ima was the highest with a response of 85%. In the post-interview, all participants suggested a less strict ratio. In fact, when they were asked if they maintained a ratio close to what they estimated, all three mentioned the need for daily flexibility and that the ratio was more of an average for the semester which they sometimes were unable to maintain for various reasons (e.g., to stay on schedule). John and Ima both cited that there were certain topics that made class periods have more lecture or the need for more clarification. Ima said that “angular and linear speed” was something that her students did not like and so it “took longer to do out loud.”

## **4.2 Challenges**

The challenge that all three participants expected to face was that students would push back against this new style and that a lot of time would be spent working on marketing the course and its expectations. This response is consistent with what the participants heard during their training in August. During that training, there was a two-

hour period devoted to how to get students to “buy-in” as well as time designated for former instructors to talk about how they dealt with student push-back.

In the post-interview, Ima is the only one who didn't feel like student pushback was as big of a problem as she anticipated. Ima said that she had a lot of problems with students' inappropriate use of technology, like students being on Facebook during class. She noted that this problem was not unique to the new pedagogy, but to group settings generally since one person being on Facebook would now affect their whole group. This was in contrast to being on Facebook only affecting that individual in a traditional lecture class. John simply spoke to his struggle to motivate students. He did not think this was a unique challenge for IBL, but that students “not being fed all of the answers (like they are used to)” made it harder to motivate them. Maria and Ima both had their own list of challenges in addition to the anticipated pushback.

Maria stated that she didn't think students understood “the new structure” and this lack of understanding was a “daily challenge”. Maria also went in depth during the post-interview about the challenges that she felt were due to the course being coordinated. For example, when she was a discussion leader for a calculus section before she began teaching the Trig course, she did not use multiple-choice questions and therefore was able to give students partial credit on assessments. She mentioned that she understood that coordinated courses often used multiple-choice questions (and that all students in the Trig course had the same ones), but that she wished she had been able to give her students points for their thought process and not just answers. Maria also said that she thought it was “unfair to the students” that they did not get their Scantrons returned to them. She also went in depth about the online homework that the

students were expected to complete. She stated that it was “a lot of hassle” although it was nice to not “have to grade everything.” The online homework presented students with the same issue of right or wrong answers, but sometimes the site did not accept the right answer.

The final question in the post-interview asked how they would advise an incoming graduate student that was about to teach this course for the first time. John stayed consistent with his statement about student buy-in (which he said was a challenge in both the pre- and post-interviews). He said that “it is easy for them to give up really early” and that the instructor needs to “really enforce [their expectations].” Ima and Maria discussed the idea that the workbook should be seen as a guide that could/should be manipulated for the use of each instructor. Each implied their sense of needing to follow it directly at the beginning of the semester, but by the end of the semester, they realized the need to be flexible with its instructions and questions. Maria said she didn’t always like “the way the workbook would present a problem”, and Ima said “I don’t think that you have to follow the workbook as closely as what I thought we had to.” Maria had feelings that were similar to John about student push-back being a potential issue for a new instructor and said, “prepare yourself, be strong... Prepare to be devastated... you have to be strong.”

### **4.3 Goals for Students as Instructors**

Each participant had their own hope(s) for their students that were consistent through both interviews. In the pre-interview, Maria hoped that students would learn that “math is a subject where you do self-discovery”, and that they would learn to cooperate with each other in-group settings. In our post-interview, Maria said that she

hoped that students would “be more independent with their studying” and that they would learn “teamwork.” John originally hoped that his students would “appreciate the fact that... they have capabilities beyond what they think they do.” He explicitly mentioned that he was not concerned about their long-term memory in regard to specific mathematics content. In the post interview, John said he hoped that they “appreciate the new way of thinking... [if they are] successful then [the new way of thinking] is very fruitful and rewarding.” Ima’s pre-interview hope was that her students would “be comfortable talking to people” and her post-interview response was “maybe they would learn how to talk/communicate.”

#### **4.4 Refreezing**

In the follow up email, participants were asked to conjecture about their future use of inquiry-based learning in their classrooms. This was written as two separate questions to attempt to see if the role of coordination would have an effect on their responses. Maria stated that she “will definitely apply active-learning techniques in any class I am teaching next whether it is a coordinated course or not.” Although she sees the value in active learning, she went on to say, “but depending on the course I will decide how much active learning I want to implement.” John had a similar response in that he “believe(s) students would learn a lot better this way” when talking about his experience teaching with IBL. However, he also said that the next course he taught would be “a much more active learning-friendly one,” which does not imply that he would teach an inquiry-based course. The statement does indicate that he has learned different techniques using IBL that he will continue to use. Ima started by simply answering, “definitely” to the question about whether or not she would continue using



IBL, but like the other participants, had the caveat that she would like do about “70% active, 30% lecture” in her next course.

## **Chapter 5: Discussion**

### **5.1 Response to Research Question**

This study highlights the factors that provide psychological safety for graduate students to make the change to inquiry-based learning, specifically in a coordinated course. The main results that demonstrate their sense of psychological safety come from the responses in regard to their goals as well as their potential future use of this teaching style. The fact that their respective goals remained consistent shows that they did not feel a loss of integrity or identity, as required by the definition given. All three participants saying that they would continue IBL in the future reveals a positive self-image that helped produce results that were consistent with their stated objectives. These statements explicitly display their sense of psychological safety that will potentially lead to changing their pedagogy. Another aspect of their psychological safety is tied to the fact that they were able to really focus on the day-to-day operations in their classroom.

This is something that is shown through their responses because of what is not said. When asked about the easiest parts of the transition to teaching the Trig course, all three participants mentioned the workbook that was created for them. Ima did not state anything in regard to making the transition easier and instead focused on the hardest parts. John mentioned that it was easier for him to transition because Trig was a course “that truly captures the essence of mathematics”. Maria stated that the “easiest part was that course was structured in advance. The workbook, quizzes and exams were prepared already”. Notice that none of the participants mentioned their classrooms being

conducive to active learning, having a smaller number of students, having an LA to help them with day-to-day paperwork and answering questions, the weekly meetings or reduced size of content. The lack of mentioning these aspects signifies a strong sense of psychological safety that the participants may not have been aware of.

Analysis of the data suggests that the University's mathematics department got rid of many of the potential barriers of implementing inquiry-based learning. The graduate students that agreed to teach Trig took on that task knowing that they would be in classrooms conducive to group work, the traditional content to be covered had been reduced, their class sizes would have a strict size limit, and that the department not only supported but expected them to use IBL. On top of that, the instructors would be working with an undergraduate LA and would be using the workbook created to facilitate discovery learning. This meant that the instructors would only be taking on the cited barrier of student pushback to this teaching style (see Section 2.1). This unique situation may not be available to all graduate students and/or all coordinated courses.

## **5.2 Defining Inquiry Based Learning**

On the first interview question, there was a distinct shift in all three participants' definition of IBL. There was also a change in their response to coming up with a ratio of speaking/activities during class time. Initially, they all cited their own roles as instructors when defining IBL and they all gave a strict majority ratio with the majority of the time given to student speaking and activities. It is worth noting here that all three participants had a very short "unfreezing" process due to the nature of receiving teaching assignments. They all said that they would prefer teaching this course, knowing it would be taught this way, and then were put in a situation where they did not

have an option to revert to earlier teaching methods. At the beginning of the semester, Ima and Maria felt the need to strictly follow the workbook, which may be related to their previous experiences in a coordinated course.

The shift in their responses could be attributed to the participants being in the “changing” phase. One of their changes is evident through their clearly defined ratio changing to a more fluid, “on average” statement about their day-to-day classroom practice. It also is shown in their definition of IBL moving from instructor-centered to student-centered. This could be attributed to the fact that they were all recently part of the same professional development that described the way that the course would be run. This professional development may be the reason that they had definitions that involved their own role and they all had strict majority ratios.

In fact, in their general training before they started graduate school and in the training before teaching the Trig course, the participants heard about fixed vs. growth mindset. Individuals that have a fixed mindset “believe their talents and abilities are simply fixed” (Dweck, 2009, p. 1), whereas those with a growth mindset “think of talents and abilities as things they can develop-as potentials that come to fruition through effort, practice and instruction” (p. 1). This is a topic that instructors were expected to bring up with their students and had specific lesson plans in the workbook. Maria mentioned in her post interview, “we have been telling them in this class over and over...about fixed mindset and growth mindset.” The change in the instructors’ mindset about the course could perhaps be contributed to their previous fixed mindset about teaching and about IBL as compared to their growth mindset coming out of teaching the course.

The student-centered definitions of IBL in the post-interview may not be a strictly positive outcome. In these definitions stated by the participants, the role of the teacher as a facilitator did not seem to exist. All three participants mentioned that students had a large responsibility for the material of the course. There was a sense that if the students weren't trying hard or doing enough that they would not be successful (without any acknowledgement of the instructor's role). Ima said that some students "aren't willing to put in the work that it takes". John stated, "The students who cared and put the work in, I think they will appreciate the new way of thinking." This mindset may be true about teaching a traditional lecture course as well. For example, Ima mentioned that she has "always had back row students" but that they weren't "actively hurting other people in their group" when they were in the back row of a lecture course.

### **5.3 Challenges**

The fear of student pushback, the largest challenge stated by the participants coming into the course, can be attributed to the professional development devoting hours to this particular idea. The professional development group likely believed that pushback would be one of their biggest challenges due to the fact that the other typically cited barriers to making this pedagogical change were handled by the department. All instructors had small class sizes, were given classrooms where group work would be easy to facilitate, the departmental norm for this particular course is that it would be taught using IBL, and they do not have tenure as a pressing concern. It would be much harder for daily group work in a lecture hall with auditorium seating and a large class size. It is worth noting that since TAs are paid to teach this course and

since it is coordinated by faculty, there is pressure to teach this course according to the coordinator's requests.

#### **5.4 Goals as Instructors**

The consistency of the TAs' hopes for their students is not surprising. Since each participant had stated a goal that was not necessary directly tied to their specific content, it makes sense that the goal would not change. In fact, it is possible that these goals might be consistent throughout their time teaching and not just specific to the semester studied. The research by Samuelowicz and Bain (see Section 2.2.2) supported the idea that many instructors have goals that are not specific to content. However, it is worth noting that these individuals made the choice to try IBL, which research has shown to better align classroom practice with goals that are not specific to content.

#### **5.5 Refreezing**

Maria, Ima and John both had interesting responses about their future use of active learning techniques. They all three seemed to be sure that they would continue using some parts of IBL, but they may not have the same level of implementation that they are currently using in the Trig course. The participants might be describing a technique similar to a "hybrid" IBL course. Hayward (2015) defined hybrid IBL techniques as instructors that "incorporate some IBL strategies into a more traditional class, which may serve as a more feasible and less daunting entry into IBL but may then lead to 'full IBL.'" (p. 10). Using a hybrid style may also suggest their awareness of the potential barriers they will face when teaching a different course.

## **Chapter 6: Conclusion**

### **6.1 Limitations**

The largest obstacle for the researcher during this project was a lack of time due to the nature of being a graduate student. The researcher was taking classes and teaching throughout the data collection and analysis. Another limitation is the type of data that is presented above. The subsequent results are based on interviews done with the participants. Self-reporting may not always present completely accurate information. In regard to this paper, it was the best way to gain insight of the feelings and perspectives of the participants. This means there is a need for more research to be done.

### **6.2 Future Research**

This paper serves as a call for larger studies and longitudinal studies of graduate students that change to active learning techniques while teaching a coordinated course. The larger studies may provide insight into general outcomes from a majority of the teaching assistants. A longitudinal case study similar to this one or on a larger scale could provide insight as to whether or not these graduate students are more likely to continue using inquiry-based learning strategies.

There are also many aspects of this particular course setting to be explored. For example, the role of the undergraduate learning assistants as well as their own experiences with professional development, working alongside a graduate teaching assistant, is a subject that is in need of more research. There was also nothing done in regard to the students of the participants, particularly in the students' affect or success. Both items are worth exploration to further compare the participants' IBL implementations. Another interesting aspect would be to look into the creation,

implementation, and adaptation of the workbook used in courses similar to the one studied.

### **6.3 Summary**

The implementation of active learning has been shown to have many positive effects for students (e.g. Laursen 2014). This study sheds light on how to help developing mathematicians in the teaching field attempt inquiry-based learning in their own classrooms. The researcher claims, from the data, that the instructors went from a very fixed definition of IBL and its potential challenges to a more dynamic understanding of its benefits and obstacles. The definitions given in the post-interview show a wider range of possible IBL classrooms and thus may make IBL more adaptable to not only the participants, but to others. This may imply in their “refreezing” stage that these instructors will be more likely to continue with IBL methods.

All three participants had non-content specific goals in mind for their students before the semester began, and those goals remained constant throughout their semester. It could be concluded, as it is supported by the Laursen (2014) study, that their students experienced greater gains towards these goals because the participants were using IBL. Having greater gains towards the goals they have for their students may imply a stronger likelihood that participants will continue using IBL.

Nearly all of the cited barriers to IBL (see Section 2.1) were not an issue for the participants. They were able to implement IBL with their only worry being how their students would react to the change in pedagogy. The participants were even given extra support within their own classroom through the LA. The fact that the participants did not mention the tools that they were provided with or the specific physical layout of

their classroom may imply that they do not see these things as potential barriers to implementing IBL. The classroom setup provided them with the psychological safety, which is key to the “unfreezing” stage, that they may not even be aware of.

Even though all three teachers had unique experiences throughout the semester, they all agreed that their teaching style would incorporate more active learning in the future, thus implying that the psychological safety that the participants had may lead to a “refreezing” of their teaching methods that incorporates IBL. Although it is important to note that the data for this result is hypothetical since the participants are merely speculating about their future courses. This paper serves as a starting point for more research in the intersection of graduate students teaching coordinated courses using inquiry-based learning techniques.



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## **Appendix A: Questions from the Pre-Interview**

1. What background do you have in terms of teaching?
2. What is "teaching mathematics"?
3. How do you define IBL?
4. In an inquiry-based classroom, what do you believe should be the ratio of teacher/student speaking and why?
5. What challenges do you expect to face this semester?
6. Are any of these challenges unique to the IBL classroom environment (if so, which ones)?
7. What do you think your students will take away (if anything) from this course? What do you think they will remember twenty years from now? What do you hope your students will take away from this course?

## **Appendix B: Questions from the Post-Interview**

1. How do you define IBL?
2. In an inquiry-based classroom, what do you believe should be the ratio of teacher/student speaking and why?
3. Do you believe that you were able to maintain a ratio close to the one mentioned above? (If so, why? If not, why not?)
4. What challenges did you face this semester?
5. Are any of these challenges unique to the IBL classroom environment (if so, which ones)?
6. What do you think that students will take with them (if anything) from this course? What will they remember in twenty years? What do you hope they will take with them?
7. Is there anything you would do differently looking back at your last semester?
8. What advice would you give to an incoming TA about teaching this course?

## Appendix C: Questions from Follow Up Email

1. What was the easiest part of transitioning to teaching in 1523? The hardest?
2. Do you think if you taught a different coordinated course next semester that you would use more active learning in your classroom than you had before teaching 1523? Why or why not?
3. Do you think if you taught a different course that was not coordinated next semester that you would use more active learning in your classroom than you had before teaching 1523? Why or why not?
4. What does it mean to “do math”?
5. What does it mean to “teach math”?
6. How do you do math?
7. How do you think your students do math?
8. How do you think your students *should* do math?
9. Did you feel like you had to strictly follow the workbook? Why or why not?
10. Do you feel like this semester (currently) that you are strictly following the workbook?
11. What do you think could be done to the workbook to help more instructors feel like it fits their classroom, (if anything)?
12. One of you mentioned that the student “push-back” settled down but then would come back when groups were changed. Is that something that you all experienced?
13. Do you think that changing the groups is an important thing to do? Will you adjust the number of times that you changed them this semester?