Building an Active Learning Nucleus: Examining a Case Study

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Abstract

HBCUs and other smaller institutions wishing to change practices in mathematics instruction at their institutions can begin with a nucleus of dedicated personnel and initial activities and teaching strategies that will provide experience in active learning instruction for faculty and supportive data to present to key institution stakeholders. In Phase 1 of our pilot program, instructors have introduced active learning tasks and used peer collaboration in precalculus courses. In this report, we describe one case study from this implementation as an example of the learning and adaptation that may occur when faculty incorporate active learning into existing course structures.

Keywords: active learning, institutional change, case study

Introduction

An Active Learning Nucleus

Active learning can positively impact student achievement and attitude (Prince, 2004). Culture change at a small institution where faculty have heavy teaching, research, and service responsibilities can be challenging. It requires those who desire change and are willing to work for it. Change makers require the support and resources necessary for their work. This core of willing workers and supportive resources might be thought of as a nucleus of change. A nucleus "directs all activities that occur within [a] cell and also contains the cell's genetic material, or DNA. The nucleus gives the signal to the cell to grow, divide or make proteins" (www.reference.com). The active learning nucleus can provide a look at the pattern of active learning instruction and provide research data that supports departmental growth. Those who take the first steps in bringing active learning into an institution form the foundation upon which change can be built.

Research questions

We present a case study of a member of an active learning nucleus. This study describes changes in the practice of a faculty member, Dr. Williams, in a mathematics department at a small historically Black college (HBCU) in the southeastern United States. A pseudonym is being used to protect the confidentiality of the faculty member and her students. Our research questions are:

- What challenges arise when mathematics faculty attempt to incorporate active learning into a traditional college precalculus course?
- What emerges in examining one teacher's beginning practices in active learning that might help other institutions to effect change?

Supporting Institutional Change

When mathematics department faculty teach using an active learning paradigm, they provide more opportunities for students to engage in productive mathematical habits of mind and to use reasoning and logic, rather than just rote procedures (Mathematics Teacher Education Partnership [MTE-Partnership], 2014). Examining case studies of such situations can provide data needed to support institutional change. Tracking the process of change from the nuclear beginnings can provide empirical data that correlates with institutional goals. Colleagues learning from members of their own department can see how to more effectively implement active learning. Such collaboration can build a collegial philosophy of learning from each other needed for productive institutional change (MTE-Partnership, 2014).

Networking and Productive Learning Cycles

The three faculty members engaged in the implementation of which this case study is a part began their work with materials provided through the Active Learning Mathematics Research Action Cluster (ALM-RAC) network. They chose the University of Nebraska-Lincoln (UNL) precalculus materials and obtained permission to try three to five activities. After trying these activities, they decided that creating their own materials based upon the ideas they saw in the UNL materials would be more effective for their students. In this way, the networked support from the ALM-RAC provided base-line materials that gave the faculty members experience with active learning and allowed them to study the use of those materials and act to change the implementation. This case study will describe one faculty member's experience with this process.

Description

Methods

Dr. Williams' practice during the 2016-2017 academic year was examined through a semi-structured interview conducted by the lead author at the end of the fall 2016 semester and an observation conducted during the spring 2017 semester. In addition, Dr. Williams described her own choices and implementations in writing, responded to follow-up questions, and collected student survey data about the activities. The purpose of the interview was to determine Dr. Williams' thoughts about the fall implementation and any changes she hoped to make during the spring semester. The observation was conducted during the spring semester to confirm Dr. Williams's understanding of active learning. The observer used the Math Classroom Observation Protocol for Practices ($MCOP^2$) (Gleason, Livers, & Zelkowski, 2015) and took field notes. The course observed was Precalculus Algebra, and the lesson topic that day was domains and graphs of logarithmic functions. Dr. Williams also provided grades and student learning outcome results for both semesters. Student learning outcomes are learning goals set by the mathematics department as measures of student achievement. The findings reported here focus on interview and observation data, written descriptions of practice, and student surveys.

Findings

The teaching strategies employed by Dr. Williams included pausing during lectures to ask students to continue an example using prior knowledge to engage them in the whole group discussion. She also was able to discover gaps in prior knowledge. She gave them exercises to work on their own in class, allowing students to present work. When students presented work, she allowed the class to ask the presenting student questions before going over the work herself. Her self-described understanding of active learning was as a process in which students "engage . . . through discussion, critical thinking, or other actions, rather than passively receiving information via lecture or similar format."

Active learning implementation fall 2016. Dr. Williams described the challenges she had incorporating active learning into the fall 2016 semester. She said that her students were "needier . . . than usual and ... less capable of problem solving on their own."

> They just – had a harder time getting to think for themselves about things. And so that actually ... kind of rolled into when we were doing the active learning activities. They just seemed like a lot of them just felt lost about how to approach it.

During the fall 2016 semester Dr. Williams implemented two tasks drawn from the UNL precalculus course: a linear functions group activity and a combining transformations group activity. Students were asked to work together in groups to answer six to seven questions during a class period, and they were asked to turn in their work for three of those questions. She covered some of the basics the day before and discussed the activities at the beginning of the next class meeting. During the activity, Dr. Williams walked among the groups and answered questions, trying to keep her answers to questions and hints as brief and open-ended as possible. She emphasized student thinking, encouraging them to see what they could come up with on their own. Rather than answer the question, "Is this right?" she encouraged them to compare their work with another group's work. During the interview, she described her experiences:

> [M]y goal was to just let them go and let them work and make them work through it as best they could together hoping they would help each other out. Many of the groups ended up raising their hands and just saying, "we just have no idea what to do with this" and so I tried to give them hints about, "Well try thinking about it like this." I tried to not just give away any of it and there were some moments when I thought, "I wish I hadn't said this much." Like I made a jump for them they could have made. … [T]he second activity – went about the same way. … Again I felt like they just ... didn't have the tools or couldn't make the jump of trying new things – trying to figure things out on their own. So in both cases that has been the same situation of they tried to work together – ended up feeling stuck – I had to give [loads of] hints.

To address the challenges seen during the first semester, she decided to break the work up into smaller pieces and to spend more time "unpacking what [they] had done." Among the ideas she had for unpacking were "going over what they'd done" and "asking them questions about what their thought process had been." She felt that she should have done more "thinking ahead" about how to use the activities. She said, "I will be more deliberate about what activities I pick and more thoughtful about fitting it in."

At the end of the semester, students evaluated the activities they had done in class. The dominant theme among their responses was that they benefited most from working together with their peers. The reasons that students said they liked working together fell into three main categories: 1) someone else was able to help them with problems they didn't understand, 2) hearing their classmates explain their different thought processes reinforced multiple ways of thinking about a problem, and 3) after explaining their own thought processes to their classmates, they had a stronger understanding of the material.

Active learning implementation spring 2017. During the Spring 2017 semester, Dr. Williams used activities designed to better meet the needs of her students rather than using the UNL materials. In the fall, she had circulated to observe the students' work and found that most groups were not been able to complete the UNL

assignment during the class period and had jumped ahead so they could get to the three problems she was requiring them to submit. For Spring, the number of questions in the active learning activity was reduced. Her choice was not based upon the differing spring population of students, but rather on her desire that they complete the assignment in class, have time to think deeply about the assignment, and that she meet the goal of covering all required topics during the semester. She said, “I don’t think there is enough total class time in the semester to dedicate more than one class to each of [the active learning activities].” The new activities included one or two warm-up problems and one applied problem (with multiple parts). Students turned in all of their work.

While the activities in the fall were more thorough and the students explored similar questions from more angles, the spring activities were more focused so that most of the students were working on the same questions at any given time. This change promoted more interaction between groups. The two spring active learning activities she tried were an inequalities group activity (graph the solution set of an inequality) and a logarithmic functions group activity (recognize the graph of a logarithmic function and interpret a logarithmic function as the inverse of an exponential function).

After the inequalities group activity, students evaluated the activity they had just completed. Similarly to the end-of-semester evaluations from the fall, students felt that they understood the material better when working with their peers. They enjoyed receiving help and being able to compare answers and methods.

Dr. Williams noted that many of the students needed an extra push to interact with one another. To help with this problem, she required them to submit the name of at least one classmate with whom they had compared their answers. The need for students to be pushed was confirmed during the observed lesson. Students were very quiet, with about half of them talking about mathematics. Although most appeared to be trying to solve the problem, only a handful of students (about three) appeared to persevere in getting help.

The questions in the logarithmic functions activity included the instruction "Give reasons for your answers.” To support students who were uncertain about how to give reasons, she reminded them that there wasn't a "right" explanation. She prompted them with encouragements to explain their thinking, such as “If you have an answer, there is something that led you to that answer, and that's what I want to hear about." In the observed lesson, she encouraged them to remember “something [they] thought” and to reason. She worked hard to get a reluctant class to talk to one another. She encouraged student-student interaction and support, suggesting they talk to “someone in this row.” Observed prompts included:

“Give a sentence or two about why you think that’s the best match.”

“Not a specific method we’ve learned. I just want you to try to figure it out.”

“Try to convince yourself.”

“Have you found one that you think matches?”

“There was something you thought . . . something solid.”

“Talk to the people around you.”

“Try to come up with at least one sentence.”

“See if anybody else around you had an idea.”

“I’m not going to say whether it’s right or wrong.”

“Try to think of other things you can match up.”

Summary. Dr. Williams’ work during the observed lesson confirmed that she understood the goals of active learning. Although only two active learning lessons were implemented each semester, she had a chance to try active learning and adjust her way of using active learning. She realized her own tendencies to want to say too much as she tried to help students during the fall 2016 semester. She also learned that students liked working together to get help, hearing explanations, and learning from explaining to each other. She streamlined the

implementation for the spring semester. Her questioning supported reasoning and collaboration. She gained experience provoking a reluctant class to participate, think, and problem solve. Following the spring semester, she said in response to additional questions, "I think early and regular active learning experiences will go a long way toward establishing expectations and patterns." Even though her standard teaching practice involved engaging students in classroom discussion, the transition to active learning was challenging for students.

Conclusion

Activities created for the spring semester had fewer questions so that activities could be completed during the time allowed for topics during the semester. This choice was based upon the time it took for students to complete the activities during class. Dr. Williams learned more about what types of activities are needed and what it takes to help students learn via the active learning paradigm. This work provides the MTE-Partnership with insight into the needs and challenges faced by mathematics faculty who incorporate active learning within strict departmental parameters in a traditional culture. Faculty members need to know that active learning is a change in learning paradigm for students and that students and instructors need consistency and time to develop a productive active learning relationship. Faculty members also need to understand the work, types of questions, and consistent effort it will take on their part to help their students through this process. The experience of this faculty member and others will be used to continue to refine and expand the active learning offerings at the institution.

For More Information

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