Creating a Collaborative Environment with University Faculty and Community College Faculty to Engage Students in Learning Statistics

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Abstract
The Modules for Teaching Statistics with Pedagogy using Active Learning (MTStatPAL) project team has designed learning materials for actively engaging students in learning introductory statistics material. They have also developed corresponding instructor materials with built-in professional development components to aide instructors who are new to teaching with active learning materials. These materials were tested at the authors' own four-year university where they have now transformed their introductory statistics course. To determine if the materials and instructional approaches were appropriate for students and instructors at two-year institutions, the project team developed a collaboration with faculty teaching introductory statistics at a two-year institution in their region. This pilot study revealed that the materials were appropriate for this student population. Furthermore, it also revealed the power of the partnership between the faculty participants at these two institutions. This article reports on the experiences of the faculty members involved in this collaboration and the strengths and weaknesses of the collaboration and professional development.

Key Words: Statistics Education, Active Learning, Professional Development, Community College

1. Engaging Students in Introductory Statistics: Background

The Modules for Teaching Statistics with Pedagogy using Active Learning (MTStatPAL) research group designed learning modules for an introductory statistics course to improve student success by disseminating best teaching practices across the many sections of this course. During the class-testing by faculty at Middle Tennessee State University (MTSU), but outside the MTStatPAL project, we observed that faculty new to active learning have a hard time implementing the modules without support. Many faculty members do not have formal statistical training in their undergraduate or graduate coursework. Further, many do not have training in using active learning. To help overcome

these issues, we first developed a model at our own campus to transition faculty who primarily lectured to teach introductory statistics using active, engaging methods. Then we developed a collaboration with faculty teaching introductory statistics at Columbia State Community College (CSCC) where we tested both the active learning materials and a model for faculty professional development. This paper will first briefly describe the project at MTSU to provide a context to better understand the collaboration with community college faculty. Next, this paper will report on the experiences of the faculty members involved in the collaboration and the strengths and weaknesses of this long-distance professional development model for making a large-scale transition in teaching pedagogy. We will also include results from the student pre- and post-tests and ease of use surveys which allow comparisons between community college and university students using these teaching materials and this instructional approach.

1.1 MTSU Goals for Introductory Statistics

The MTStatPAL project began at MTSU in 2014 when it was observed that the introductory statistics course here was taught with varying methods, and with varying content. A student who took the course from Professor A could have a different experience (for example a different instructional method covering different statistical content) than a student who took the course from Professor B. This is a result of the differing backgrounds of the instructors: some had a mathematical background rather than a statistical one; some were new to teaching altogether; and some were new to teaching using active learning.

The introductory statistics course at MTSU is an algebra-based, general education course taken by a variety of majors outside of STEM. Class sizes generally range from 20 to 40 students. Students use a graphing calculator to complete computations so they can focus on interpreting their results. Teachers of this course at MTSU have a variety of backgrounds and experience with some trained in mathematics and others in statistics, and some have taught for many years and others are new to teaching (for example graduate assistants). Prior to this project, some used a variety of methods (e.g. applet investigations, flipped classrooms, project-based learning) to engage students and others only lectured, seeking minimal input from students.

The MTStatPAL project team wanted to engage students in learning statistics in all sections of introductory statistics.

Active learning is a pedagogy that increases student engagement. The GAISE recommendations (Aliaga, et al., 2005) (Carver, et al., 2016) included active learning as one of several recommendations to improve the teaching of statistics. A recent meta-analysis (Freeman, et al., 2014) found that students who experienced active learning had higher grades and better understanding than students in more traditional classes. Over time, we have been able to make a sustainable change at MTSU. Our approach included selecting existing high quality materials and developing some additional new materials to promote active learning and developing a community of faculty who have a commitment to student success in developing statistical problem solving abilities.

1.2 Modules for Teaching Statistics with Pedagogies using Active Learning (MTStatPAL)

When creating the MTStatPAL materials, the goal of active learning led to incorporating active experiences, including prompts and time for student-to-student conversations, and using questions designed to foster high-level thinking about statistical topics. Developing a student workbook helped establish more of a common learning experience for all students across different sections with different teachers. The student

workbook contains ten activities for statistical concepts throughout the semester, and five-minute warm up for the days without an activity. Each of the ten activities are paired with an out-of-class activity, which consists of videos with embedded quizzes that either covers concepts necessary to do the activity the following day, or reviews concepts introduced by an activity the day before. Figure 1 lists the processes that we used to change the classroom environment in introductory statistics.

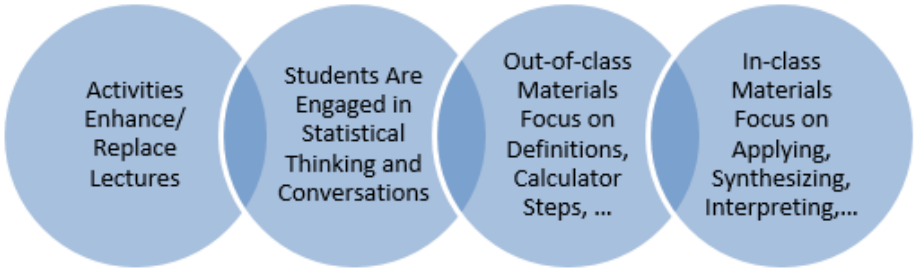

Figure 1: Changing the Classroom Environment

To make the transition to active learning easier on the teachers, a teacher workbook was also created. The teacher workbook not only has solutions, but also teaching tips for each lesson. Further, videos of more experienced teachers teaching each lesson are made available to the teachers. After class testing the materials for both the students and the teachers first in the project team classes and then in other teachers' classes, we were ready to start the transition in instruction from teacher centered lectures to a more student centered learning environment. To make this change, we knew we needed the buy in of the faculty teaching the course.

1.3 Changing the Teaching Culture by Developing a Course Community

Materials alone were not enough to change the pedagogical approach to teaching introductory statistics. Even with lesson plans and instructor videos, we needed to help teachers make a transition. We began meeting with the faculty who typically teach this course and talked about making such a large scale change. The resulting model for changing the instructional method of the course was to develop a "course community" which met during the transition year every two weeks. The fall semester was used to establish relationships between the faculty and the project team leaders to develop a more robust understanding of the statistics needed to teach the course, the types of pedagogies supported by GAISE, and to get to know each other better. The community development component of the project was very important for making the transition easier for everyone. This helped establish an atmosphere of mutual respect, which we believe made the transition easier. This community continued to meet every two weeks to discuss the course, including upcoming statistical content, the results of the previous years' final exam, and any problems in the classroom. After the initial large-scale transformation, all of the faculty members in the course community who are experienced with using active learning help the newcomers. Course community meetings continue and the transition to using engaging pedagogies and promoting students having sophisticated statistical conversations with each other as well as the teacher have been sustained.

2. Building a Collaboration: MTSU and Columbia State Community College

2.1 Partners

After successfully changing the introductory statistics course at MTSU, the research team was interested in whether this project could be extended to other schools. The faculty and administration at Columbia State Community College (CSCC) were interested in taking part. Even though there was only one community college (CC) involved, faculty participants were at three different campuses of that CC. These campuses ranged from a half-hour drive to an hour-an-a-half drive from the campus of MTSU (Figure 2).

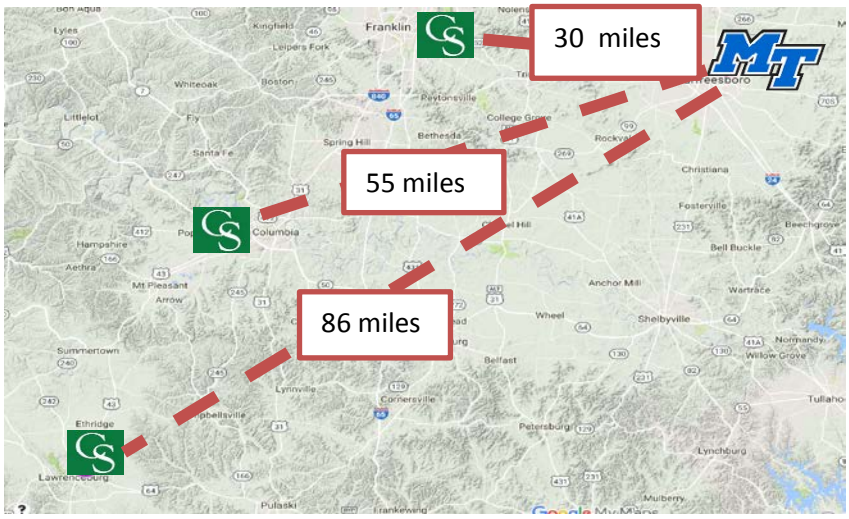

Figure 2: Partners

2.2 Logistics

A question of interest was, "What are the most effective ways to incorporate components of successful professional development programs when the faculty are separated by distance?" These components include a substantial time investment, systemic support for the instructors, opportunities for collaborative and varied learning experiences that result in acquisition of skills and knowledge, and evaluations of both student achievement and the immediate and ongoing impact on professional practice (Ohio Department of Education).

The collaborative model for transitioning to using active learning or for incorporating additional active learning materials included a few timely face-to-face meetings, emails, designated mentor/mentee partners, and a designated leader at each institution. Other support materials for this teaching transition included the MTStatPAL materials, suitably changed for use at CSCC; a student booklet with ten full-class active learning modules and five minute daily warmups to continue student-to-student conversations; a corresponding teacher manual with solutions to the student workbook, but also with helpful hints for each module and suggestions for things to teach each class period; videos of experienced instructions teaching the active learning modules; and instructions for accessing videos for students to watch and corresponding quizzes for the students to ensure they are prepared to effectively complete the in-class activities or to extend concepts from class. The changes that were needed to suit these materials for use at

CSCC included adding in Quality Enhancement Program (QEP) questions; deciding what to do about the parts of the curriculum that were different between the schools; and writing a common calendar that fit their needs. These modifications were decided on by the CSCC faculty. Due to lessons that were learned in implementing the project at MTSU, at CSCC a leader was selected whose responsibility it would be to call course community meetings; ensure that the teachers were sticking to the calendar that they had decided on at the beginning of the semester; and be a resource for anyone encountering difficulty, for example if supplies were missing, etc.

CSCC has several different campuses, all of which are at least half an hour's drive from the MTSU campus. This distance made it difficult to meet in person. Therefore, the project calendar was set up so that in-person meetings only happened at the very beginning and at the very end of the project. Otherwise, communication happened by phone or email. In August, before the start of the fall semester, there was a face-to-face meeting in which the MTStatPAL materials were modified to fit the curriculum at CSCC. Also, mentor/mentee partnerships were decided on, and contact information was traded. The first day of the new semester, MTSU faculty attended the classes of the CSCC faculty. This was partly due to the need to administer consent forms, and partly to continue the relationship aspect of the partnership. Weekly during the semesters, mentors at MTSU and mentees at CSCC would exchange emails to ensure that any questions the CSCC faculty had would be answered satisfactorily. Finally, at the end of the semester, all of the faculty got together to "debrief" about how the project had gone.

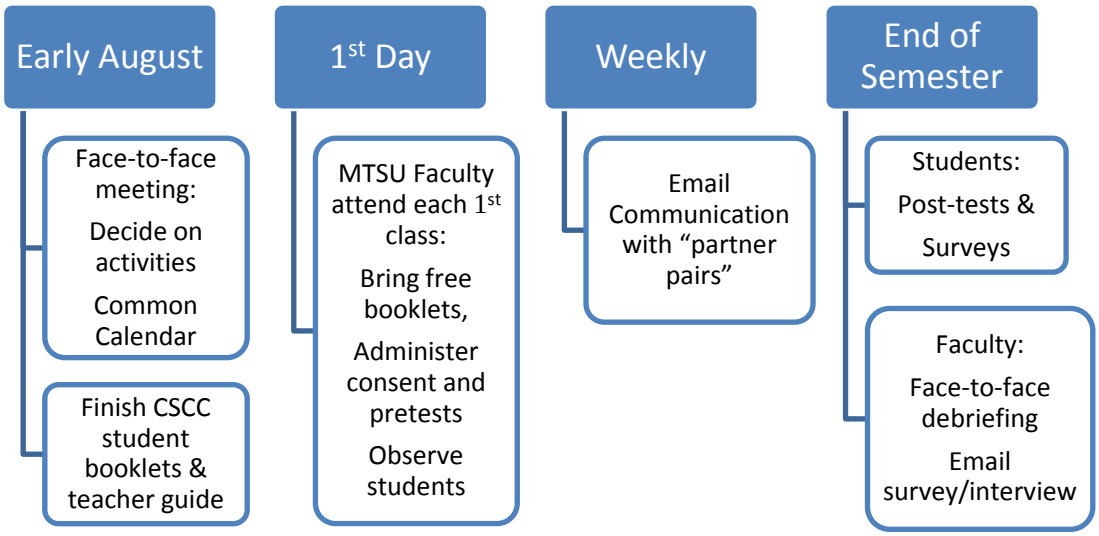

Figure 3: Schedule for MTStatPAL Collaboration

2.3 Student Outcomes

Each instructor, at MTSU and at CSCC, administered pretests and posttests to their students. The results of these are in Figure 4. While the CSCC students started and

ended with scores a little lower than the MTSU students, the overall improvement was similar.

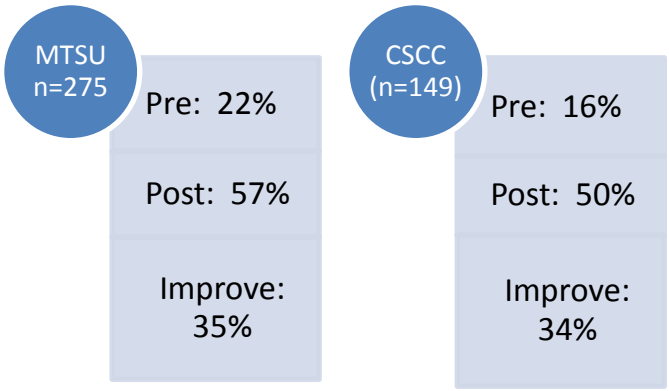

Figure 4: Pretest and Post-test Data

The students were also asked, at the end of the semester, to complete a survey about their experience with this teaching method. The results, divided into the questions about the in-class portion of the experience and the out-of-class portion, are in Table 1 and Table 2. The students at CSCC had more technical difficulties with the video quizzes than the students at MTSU. This may be a result of the distance between the schools making it more difficult to get the videos set up at the beginning of the semester. Perhaps as a result of the technical difficulties, the students at CSCC were less likely to report that the videos were easy to use and that they helped the learn statistical concepts. Since this project, one of the CSCC faculty moved the video links into a different software, and their students are having much less trouble with the technological aspect now.

In-Class Activity	**MTSU**	**CSCC**
Directions Easy to Understand	89%	92%
Helped Me Understand Statistical Concepts	78%	80%
Effectiveness of Lessons	79%	82%
I Prefer Lessons Taught this Way	78%	74%

Table 1: Student Survey Responses about In-class Activities

Online Videos with Quizzes	**MTSU**	**CSCC**
Completed at least 80%	94%	91%
Technical Difficulties	19%	28%
Easy to Use	91%	85%
Helped Me Understand Statistical Concepts	76%	65%

Table 2: Student Survey Responses about Out-of-Class Video Quizzes

2.4 Faculty Perspectives

Faculty at both institutions reported success with regard to increasing student engagement in the classroom. When asked what their primary difficulty implementing this project was, the CSCC faculty as a whole mentioned the problem of knowing when and how to step in during student-to-student conversations to help students come to correct interpretations, but also allow them to have a productive struggle making meaning on their own. Finally, the CSCC faculty noted that teachers differ in their implementation of instruction with regard to supporting student thinking during their small group and whole class discussions. As a result, they expressed their desire for more professional development to support this implementation of active learning. This makes sense in the context of the overall project, because the MTSU teachers had a whole semester of course community building and professional development before the implementation of the MTStatPAL materials, while the CSCC teachers had one day.

When asked about their experiences, the CSCC faculty divided their response into two parts. One is how to adequately prepare outside the classroom for an active learning-based class. The other is striking a balance in the classroom to make sure that learning is happening.

2.4.1 Adequately Preparing Outside the Classroom

The faculty at CSCC encountered some challenges in implementing this project. Each of the challenges in this section can be thought of as affecting the preparation stage of running a classroom. One challenge was building a course community similar to that at MTSU but with literal miles between them. A supportive course community can make it easier for an individual instructor to run a class, since it can answer any questions, it can be a place to ask for substitutes when necessary, and the other members of the community can help trouble-shoot any issues that arise during the teaching of the course. Meeting before the semester started helped build community, and then the course community could be sustained through electronic means. Another challenge was making and sticking to a course calendar. The MTSU faculty had found this to be especially helpful in having a course community, because it meant that all of the faculty was covering the same topic at the same time. Having a project leader helped with this part of the project. The CSCC faculty also had to include the college's Quality Enhancement Plan (QEP). CSCC had decided to include writing exercises in most courses as part of the QEP, these exercises had already been decided on for this course. To make the two projects work together, some of the daily "warmup" activities were replaced with QEP questions. The planning for this happened before the workbooks were printed, so for the faculty and students at CSCC, the QEP looked like just more of their regular classwork. Another challenge was in the class makeup. CSCC students have different backgrounds than MTSU students, but also the students at the different campuses of CSCC had differing backgrounds as well. Having a course community helped instructors decide how to handle their students, but a certain degree of flexibility was given to each instructor as well. Creating relationships with the mentors was also a concern. Mentors made an effort to be a resource rather than another responsibility to take care of. Finally, "selling" the project to the students was also a challenge. One teacher made the mistake of talking about all the extra work the project would be. However, by the end of the project, students expressed that they liked this method of teaching.

2.4.2 The Challenges of Striking a Balance in the Classroom

There are also challenges with implementing this project that can be thought of as affecting what happens inside the classroom. For example, the video homework that was paired with each in-class activity often contained calculator steps. Spending class time re-teaching the steps of using the calculator would just teach the students that the video homework was not a necessary part of the class, and would use precious class time on something that students could learn on their own, therefore reducing the class time available for more complicated topics. Thus, teachers had to get used to refocusing their lectures to only cover material that was not taught in an activity or in homework. Students often worked in groups, so telling group members to explain things to the other students in their group helped solidify the material for the students who had done the homework or activity as well as teach it to students who missed it.

In general, teachers had to learn to not be "helicopter teachers" during the activities. When a teacher jumps in too quickly they send the message that they don't think that students can figure out the material. Teachers had to learn instead to listen to the discussions that students were having in their groups, to encourage these discussions, and to ask more questions instead of answering questions.

Finally, silence feels awkward, and teachers had to learn how to battle these awkward silences. For example, some "battle-techniques" include reassuring students that wrong answers can be helpful to foster discussion; calling students by name, perhaps in a random way; framing questions to connect to a specific situation; or just accepting that sometimes learning is happening in the silence.

3. Discussion

The goal of this project is to increase the use of active learning in a widespread way. This rests upon the idea, previously tested by other authors, that active learning can increase student learning and retention. The MTStatPAL project was designed around putting structures in place to enable instructors to overcome roadblocks to implementing active learning. For example, if instructors new to active learning don't know which activities to use, they were provided with some. If they were worried about covering everything they need to cover in a semester, they were provided with on-line videos for students to learn outside of class time, and they are also provided with a suggested calendar to follow. If they are not sure how to implement the activities, they were provided with scripts, teaching tips, and videos of more experienced instructors doing the lesson. If they felt during the semester that something wasn't working, they had a course community to talk to about it, and to help trouble-shoot. This approach worked at MTSU, and then it worked at CSCC as well.

The CSCC instructors have all said that they still teach using active learning with combinations of MTStatPAL materials and their own materials, even though the project is over. Their success with using active learning has encouraged them that they continue to use these strategies for engaging student in their statistics class. Further, some of them have noted that they are starting to use the techniques they learned from this experience in other classes.

The next step of this project is to expand it to other schools. Can this project extend to other large universities and other community colleges in the area and across the nation?

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