Implementing Active Learning Department Wide: A Course Community for a Culture Change

Lisa Bloomer Green, Nancy McCormick, Scott McDaniel, Ginger Holmes Rowell, and Jeremy Strayer

Department of Mathematical Sciences, Middle Tennessee State University, Murfreesboro, TN; University Studies, Middle Tennessee State University, Murfreesboro, TN

ABSTRACT
A course community (CC) was formed to facilitate the implementation of active-learning materials in the Introductory Statistics course at a large southeastern U.S. university. Instructors met every two weeks for the semester before and the semester of the implementation. The CC helped instructors improve their content knowledge and pedagogical skills. Results show improvement in teacher attitudes and in student scores.

KEYWORDS
Active learning; Course community; Introductory statistics; Professional development

1. Introduction
In response to poor student outcomes in the introductory statistics course at this university, the statistics curriculum committee decided that the way the course is handled needed to change in a large-scale way. To effect this change, we instituted a course community. By “course community (CC),” we mean a group of faculty members who meet regularly to support each other with the common goal of improving student success in a specific course. This particular CC had the additional goal of changing the method of instruction in the introductory statistics courses. The choice of instructional change was from a primarily lecture-based approach to active learning. Active learning has many definitions, but in this instance, we define it as an instructional approach that actively engages students in sophisticated statistical conversations.

In this article, we will discuss the implementation of the CC at our university and its role as a successful catalyst for large-scale change. Beyond simply describing the positive impact it (and active learning course materials) had on teachers’ confidence and students’ scores, we will detail the structure of this community and how it created an environment of change and improvement. This structure includes the types of instructors involved, the goals of the community, and the schedule and activities within community meetings. Given that this community continues to thrive, even with the cessation of the grant funding the project, we believe this to be an adaptable, sustainable model of change.

2. Background/Need
At this large public university in the southeastern United States, the introductory statistics course had high failure rates and inconsistencies in both the content that was taught and the average success rates on a common final exam. The course is taught by a large number and wide variety of instructors, and often by different instructors each semester. During the time period discussed here, 32 sections (separate classes) of this course were taught by 14 different instructors from two different departments, a mathematics department and a department whose mission is to support students with underprepared (based on ACT) academic backgrounds.

Nationwide about 85% of all introductory statistics courses are taught in math departments and “fewer than 50% of the faculty teaching statistics courses in mathematics departments have at least a master’s degree in statistics” (Scheaffer and Stasny 2004, p. 269). This problem is especially acute at this university, as only 15% of the introductory statistics classes were taught by trained statisticians. Furthermore, most of the other instructors have only a master’s degree in mathematics.

All students at this university are required to take at least three credit hours of a reasoning and problem-solving course as part of the general education requirements for graduation. The algebra-based introductory statistics course meets this requirement. Therefore, it is taken by students with a wide diversity of backgrounds and majors. The course has an approximate overall annual enrollment of 900.

The two departments that teach this course have two different student populations. A mathematics department teaches a three-credit-hour version of the course to students who are academically well-prepared as measured by ACT scores. A prescribed version of the course was developed for students with an ACT score below 19. Sections of the prescribed course meet four hours per week rather than three, have a smaller number of students, and are more closely monitored by their instructors.

CONTACT Lisa Bloomer Green lisa.green@mtsu.edu Department of Mathematical Sciences, Middle Tennessee State University, PO Box 34, 1301 E. Main St., Murfreesboro, TN 37132.

© 2018 The Authors. Published with License by Taylor & Francis Group, LLC.

This is an Open Access article distributed under the terms of the Creative Commons Attribution License (http://creativecommons.org/licenses/by/4.0/), which permits unrestricted use, distribution, and reproduction in any medium, provided the original work is properly cited. The moral rights of the named author(s) have been asserted.
The prescribed version of the course contains some algebra content but otherwise covers the same course syllabus and uses the same departmental final as the standard course.

This course is of concern to the university, because it was on the list of the top 39 general education courses in terms of high DFW rates (the proportion of students with a grade of D or F, or who withdrew from the class) as stated in the president’s newsletter and faculty address in August 2013. The university has focused recently on raising student retention rates, and one way to address this is to improve learning in courses with high DFW rates.

Because active learning has been shown to be more effective as a teaching technique than traditional lecture-based teaching (Bonwell and Eison 1991; Meyers and Jones 1993; Prince 2004; Freeman et al., 2014), it was selected as an approach to facilitate improved learning in introductory statistics. However, the instructors who teach this course here may not feel confident about the course material itself, much less about implementing a new and different teaching technique. In early testing of lessons designed to increase active learning in introductory statistics at this university, we observed that new teachers tended to use the activity as an outline for a lecture-based class (Strayer et al. 2014). Furthermore, we observed in early phases of this project that implementing active learning in just one or two lessons in a course does not have the desired effect on outcomes. Instead, it must be implemented from the start of the semester and adhered to the entire semester.

Several faculty members collected and modified, with permission from their authors, some student-centered course materials. These were combined with materials developed here into a course workbook with supporting material online (Figure 1). Collectively, these will be referred to as the MTStatPAL (Modules for Teaching Statistics using Pedagogies for Active Learning) materials. The MTStatPAL materials use a flipped-classroom technique to allow time for activities in the classroom that are intended to facilitate student-to-student conversations about statistics (Green et al. n.d.). The student materials have been bundled into a workbook that students purchase for just the cost of copying at the bookstore (around US$5). The faculty materials are available online at mtstatpal.com for the instructors to easily access with a password, which is instmtstatpal.

The MTStatPAL materials were developed with an eye to possible hurdles in implementation. Teachers, for example, may be concerned about the extra preparation time active lessons can require, apprehensive about the class time taken up by active learning, and not convinced that they should change if they are already a good lecturer. Furthermore, students may dislike the expectation that they speak up in class and prefer a class in which they can watch passively. The materials address the teacher concerns about preparation time because each class day is already planned. The out-of-class activities relieve teacher worries about covering everything on the syllabus during in-class time. Addressing teacher and student resistance to change is more difficult and was a primary purpose of the Introductory Statistics course community described in this article.

3. The Implementation Solution: A CC for Professional Development

While having the MTStatPAL materials available is important, we found when we were testing them that teachers needed professional development to aid in implementation (Strayer et al. 2014). Because of the instructors’ backgrounds, they may be lacking in content knowledge, pedagogical knowledge, or statistical knowledge for teaching (the understanding of students’ hurdles when learning statistics). In other stages of the project, we successfully used mentoring as an approach to professional development (Strayer et al. 2014). For a larger-scale change, however, mentoring is not feasible. Of the 14 instructors participating in the project, only 2 had at least a master’s degree in statistics, and one more had taught this class frequently enough to be considered an expert. Therefore, we decided that a group approach to professional development was more appropriate to effect large-scale change.

We were unable to find references to the use of group-based faculty learning communities in statistics education literature. However, there is research in the larger science education field. Teachers participating in a faculty learning community...
“reported learning about and implementing new teaching strategies, focusing more on student success and student understanding, and gaining content knowledge” (Hamos et al. 2009, p. 18). In general, implementing faculty learning communities “leads to a profound change in culture.” (Cox 2004, p. 8).

### 3.1. Composition of the CC

After the start of the fall semester, all faculty members who were scheduled to teach introductory statistics were invited to participate in a CC for Introductory Statistics. A total of 13 instructors were invited to participate in the fall, and 8 were able to participate. These faculty members represented both departments responsible for the class. Experience levels ranged from MTStatPAL project team members who had taught statistics regularly for years to a participant who had never taught at all. Faculty who did not participate stated that they had schedule conflicts and were concerned about having time to commit.

In the spring, because of the full-scale implementation of the active learning in the introductory statistics course, the administration was supportive in assigning most of the CC members to teach this course again and in assigning instructors likely to be willing participants. Eleven of the 13 faculty members teaching the course in the spring agreed to participate in the CC. Those faculty members who were in the CC in the fall continued in the spring and one additional instructor who had taught the course before and had participated in early testing of the MTStatPAL materials joined the community when assigned to teach the course in the spring.

In the fall, three graduate students had been assigned to teach some standard sections of this course. They were not invited to be a part of the CC because of grant-funding conditions. During that semester, we observed that they would have benefitted from the CC, so in the spring semester the two graduate students who were assigned to teach this class were invited to participate in the community. This was a first-time teaching assignment for each. Even though they could not receive the stipend, they were appreciative of being involved in the CC and thought it was worthwhile.

In total, 14 people participated in the CC over the course of the two semesters represented in this article. Because of the various backgrounds of these people, it is unlikely that they would have all met each other without the CC as impetus. For their participation, each instructor (except the graduate students) was paid a stipend of U.S.$500 for the year, funded through an internal grant. Even after the grant funding expired, the instructors who taught Introductory Statistics (some new as well as some from this year) agreed to continue meeting the following year.

### 3.2. Activities of the CC

The CC met every two weeks during both the fall and spring semesters. Additionally, the faculty met for a full day at the end of the fall semester and a full day at the beginning of the spring semester (see Figure 2). The new materials were rolled out during the spring semester, so they met again for a full day at the end of the spring semester in order to give their opinions on and help edit the course materials.

To plan the CC, we looked to educational research, which provides information about features of effective professional development programs for improving mathematics instruction. While this research was aimed at mathematics instruction, we believe that it is equally applicable to statistics instruction. Modifying the four goals in the National Council of Teachers of Mathematics Professional Development Research Brief guidance for Mathematics Professional Development (Doerr, Goldsmith, and Lewis 2010) to reflect Statistics rather than Mathematics, we developed the following four goals.

- Build teachers’ statistical knowledge and statistical knowledge for teaching.
- Build teachers’ capacity to notice, analyze, and respond to student thinking.
- Build teachers’ productive habits of mind
- Build collegial relationships and structures that support continued learning

Furthermore, research (e.g., Ohio Department of Education 2010) indicates that for professional development programs to be successful, they must have 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.

---

**Figure 2.** Schedule of CC activities.
To encourage collegial relationships, the CC meetings were scheduled frequently. In the fall, there was not a time that everyone could meet, so there were two times for CC meetings. We were more fortunate in the spring and were all able to meet at the same time. Snacks were made available at the meetings.

To build habits of mind, the members of the community discussed broad themes of teaching philosophy as well as more immediate concerns about the administrative aspects of the course. In terms of broad themes, the faculty read the Guidelines for Assessment and Instruction in Statistics Education (GAISE) (Aliaga et al. 2005). They discussed active learning, along with teacher moves that can aid in active learning. Additionally, they discussed the curriculum for the course including what must be covered in depth and what topics can be abbreviated.

To improve their ability to respond to students, at each meeting teachers discussed what had happened in their classes the past two weeks and what was coming up in the next two weeks. Faculty helped each other trouble-shoot classroom problems, as well as attempting to resolve technical issues with the homework system. Further, the instructors were given data indicating topics that were the most difficult for students from the previous semester's common final exam in order to inform their teaching in the current semester.

One frequent topic of discussion that was not initially planned for was statistical content. When the project started, we had not understood the extent to which the instructors of this course were underprepared in statistics. We found that responding to instructors' statistical questions was a regular part of the CC meetings. The instructors really appreciated having a judgment-free setting to ask their questions. In the future, we plan to include these topics as a more planned part of the CC.

At the end of the fall semester, the faculty met to learn about the MTStatPAL active-learning materials that they would implement in the spring semester. They performed each activity in an abbreviated manner, playing the role of a student. It was also decided to attempt a common course calendar, since the fact that different teachers were on different topics had kept the faculty from being able to fully discuss issues the previous semester.

At the beginning of the spring semester, the members of the CC had another all-day meeting. This day was intended to serve as a work day to completely set up the course. Much of the day was spent in a computer lab, with faculty members finalizing their syllabus, setting up their online course components in the online homework system course shell, setting up online MTStatPAL video quiz homework, and solving technical issues. Furthermore, each faculty member received a box of materials (dice, paper plates, candy, etc.) necessary for the in-class activities. This relieved them of the necessity to search out supplies at short notice.

During the spring semester, all the faculty members in the CC implemented the MTStatPAL materials. The community continued to meet every two weeks, and conversations during these meetings were very similar to the conversations during the fall. However, the abstract discussions about teaching with active learning became specific discussions. For example, teachers might discuss a particular activity with comments about how they got less active students to participate or about which ideas their students had trouble with.

At the end of the spring semester, the CC met for another all-day meeting, which allowed the CC as a whole to discuss what had gone well and what should change. The changes that were indicated based on faculty feedback on this day were implemented over the following summer. In Fall 2016, a core group of the original CC started to serve in a mentoring role for new instructors assigned to the course.

4. Impact of the CC on Instructors

The CC members were asked to complete short surveys at every meeting. Each survey asked what had gone well in their classes in the previous two weeks, what they might want to improve, and their teaching goal for the next two weeks. At the end of each semester, instructors were given their survey responses and were asked to reflect on their own growth over the semester and the growth of their students.

Several themes emerged from reading the responses to these surveys. First, several instructors were searching for videos and activities to use in class in the fall semester. This indicates that these instructors were ready for a change similar to the one we made in the spring semester. Second, in both semesters, almost every instructor mentioned the fast pace of the course more than once. Faculty are concerned about being able to cover everything that is necessary during the semester. Third, several faculty often mentioned various concerns about their students. These concerns might include how to get students to participate, a particular student group that was not working together well, or getting everyone to complete assignments intended for outside of class time. Fourth, during the spring semester, concerns about pacing kept some instructors from fully implementing the MTStatPAL materials. Some instructors skipped an activity because of snow days, others did not use the daily warmup questions, and others turned these questions into homework.

Finally, several instructors showed a growth in knowledge and confidence throughout the year. To examine this arc of confidence-building a little closer, see Table 1, which shows statements from three faculty members at the beginning of the academic year, in December, and at the end of the academic year. These are the three instructors who had never taught introductory statistics previously and who taught in both semesters. Examining their changing attitudes over the course of the year, we see that they increased in knowledge or confidence during the first semester and increased again in the second semester.

Some outcomes of the CC were intangible and unmeasurable, yet also bear mentioning. The CC structure enabled us to handle problems, such as changes needed when snow days happened, and provided a mechanism for all instructors to work together toward a common solution. There is more collaboration among the instructors of the course than there had been previously. The instructors know each other and know who to ask if substitutes are needed. Several instructors gained in statistical knowledge over the course of the year. The emphasis on teaching reinforced that what we do as instructors matters and that it can make a difference. And teachers felt there was a secure place to vent frustrations and discuss struggles. All of these contributed to the desire of the faculty to continue with the CC even after the funding for the project had expired.
5. Impact of the Project on Student Outcomes

Student outcomes were measured with a common final exam. In the fall semester, members of the MTStatPAL project team were pilot testing the MTStatPAL workbooks. Because of the difference in teaching method between them and the other faculty members, their results are not reported in the fall semester.

The final exam was administered to all the students taking this course, and the results for this test are reported in Table 2. The Fall average values reported are the overall final exam averages for the fall semester for all students who took this course, including students of teachers in the CC. We note for the Fall that whether the workbook was used or not, the students with teachers in the CC scored higher, on average, on the final exam than students with teachers not in the CC. For the standard course, there is no statistically significant difference between the final exam scores for faculty in the CC who used the workbooks in the spring and those for faculty who did not use the workbooks in the fall. For the prescribed course, which is for less well-prepared students, final exam scores in the spring semester (CC with workbook) were statistically significantly higher than those in the fall semester (CC no workbook) ($t = 4.7$, df = $123.4$, p-value <0.0001). In fact, in that semester, the less well-prepared students’ scores were similar to the scores of the more well-prepared students.

It is difficult to attribute the gain in student outcomes from fall to spring solely to one cause. In the spring, almost all students were using the workbooks and, therefore, were experiencing active learning in the classroom. Also, most of the faculty in the spring had had the benefit of teaching this class in the fall and had more confidence because they had taught the material at least once. Most of the faculty in the spring had also participated in the CC for half a year and had been developing their understanding of how to teach statistics. There is a percentage of students taking this course in the spring who are repeaters, perhaps they did better simply because they had seen the material before, although we do not see a statistically significant difference in pretest scores. We can only observe that there was an increase and can only speculate the particular cause.

6. Discussion

Lewin (1947) divides change into three phases: (1) unfreezing; (2) change; and (3) refreezing. The unfreezing phase consists of recognizing the need for and combating resistance to change. The change phase is the actual transformation of people, structures, tasks, and technology. Finally, the refreezing phase is where the change is assessed, necessary modifications are made, and new habits are reinforced. If we apply this theory of change to the desire to increase the use of active learning in Introductory Statistics, we can see the value of the CC.

Some factors that contributed to the successful implementation of the CC include

- The major change in instructional style was discussed for over a semester before it occurred
- Collegiality was an explicit goal of the CC
- Faculty members were given time and a judgment-free space to learn the material.
- A common course calendar was implemented
- There were two coordinators of the CC to set dates, reserve rooms, and set agendas for the meetings.

Discussing the active learning material in the preceding semester increased the buy-in (unfreezing) of the faculty members who would be doing the work to implement it. The developers of the MTStatPAL materials were part of the CC and were in the final phase of testing the materials during the fall semester. Thus, at each CC meeting, they discussed how the active learning module for that part of the semester worked and which ideas were emphasized in the modules.

Kanter (1985) observed that "(h)ow people greet a change has to do with whether they feel in control of it or not. Change is exciting when it is being done by us, threatening when it is..."
being done to us” (emphasis in original). Faculty members were treated with respect as valued colleagues. They were asked for their opinions about what would work for their students, and those opinions were taken seriously. Several modifications were made to the course materials based on feedback from the faculty members. This increased their sense of ownership while also improving the materials.

It is easy to underestimate the difficulty that teachers of mathematics can have when they are asked to teach statistics. Some of these instructors had never had statistics courses in their own education, unless perhaps it was an introductory level course similar to the one they were asked to teach. This leads to understandable nervousness. In the CC, ideas such as the coefficient of determination, p-values, and types of error were discussed. Faculty members were given the chance to ask whatever questions they needed to ask in order to feel comfortable teaching this material.

The CC implemented a common course calendar in the spring semester after observing that discussions in the fall semester often devolved into “how far have you gotten?” If everyone is on the same topic, or at least within a few days of it, then discussions can focus on the ideas involved. The common calendar also serves as a reminder of the relative importance that the group as a whole has decided to place on different topics in the course.

The CC coordinators served the important functions of finding space and time to meet. They also served as a face for the community and would field E-mails from faculty involved in the community and occasionally have hallway conversations when some issue or other would come up. While we did have a CC E-mail list, teachers felt more comfortable asking content questions in person.

The CC allowed the implementation of active learning in Introductory Statistics at this university to go as smoothly as possible. The faculty members in the community were able to give each other mutual support and reinforce the value of this change. The community had a positive impact on both the teachers involved and their students.

As for the refreezing aspect of a change, the faculty teaching Introductory Statistics have continued to meet, although the funding from the grant is no longer available. The faculty involved in the CC meets every three weeks to learn and support each other in the teaching of this course. New members of the CC who were not part of the initial year report that they use the teacher videos more often than members did in the first year. They also rely on the original members to serve in a mentoring role. Members who were part of the CC in the first year report greater comfort with the material. The question of sustainability of the CC is in fact a question about whether the faculty found enough benefit to participate even when they are not compensated. Even when the grant funding was available, it was not enough to truly compensate the faculty for the extra time they spent in the CC meetings. However, they felt, on the whole, that the meetings were valuable enough that they agreed to continue meeting, although less frequently.

7. Conclusions/Future Development

If an individual instructor wishes to make a change in their method of teaching, they have only their own habits to break. While changing habits can be difficult on its own, it is made simpler by not having to agree with anyone else about what to do. However, changing how a department as a whole teaches a course is more complex. It requires not only changing habits on an individual basis, but cooperation and buy-in of all the instructors who teach the course. Furthermore, it requires a clearly articulated, shared vision of how the classroom experience should look.

Mentoring would be helpful as professional development for an individual or even a small group wishing to make a change. But when this change is desired for a large group, mentoring becomes burdensome. Choosing to use a CC instead allows for the group to share ideas and for the few more experienced individuals to disseminate their knowledge more efficiently. In this way, a CC can help instructors improve their content knowledge and pedagogical skills.

The positive results that we observed with this project have many possible explanations. The choice to participate in the CC was made by the instructors themselves, which means that it is a self-selected sample. Several of the teachers in the second semester were teaching for the second time, having taught in the fall. Perhaps the extra experience helped them understand the ideas of statistics and know how to communicate those ideas. Finally, it is difficult to disentangle how much of the improvement is due to the active learning encouraged by the MTStatPAL materials and how much is due to the CC.

The self-selection problem is difficult from a research standpoint, but from the viewpoint of the CC, it is essential that instructors be given the choice to participate or not. One of the principles of the CC’s success was the respect given to the members. Without that respect, we lose the buy-in necessary to make the change of teaching method successful. If we required membership in the CC, we would not be treating the members as valued colleagues, but as naughty children who need to be told what to do. However, it is striking that more of the faculty participated in the CC the second semester, as a percentage of the faculty teaching the course. It seems that making the CC be a beneficial support rather than one more useless meeting encouraged more participation.

Several of the instructors were teaching this course for the second time in the second semester of the project. It makes intuitive sense that more experience teaching leads to better outcomes. It is difficult to disentangle this issue from the effect of the CC and the MTStatPAL materials. This is a question that we will have to explore in future work as we seek to expand this approach to other schools.

Finally, the effect of the MTStatPAL materials was clearly positive. We argue, however, that without the CC, the MTStatPAL materials would not have been implemented as fully or as accurately. In early testing of the materials, we found a tendency of instructors to use the materials as outlines of lectures rather than as opportunities to allow students to struggle with the ideas at hand.

Large-scale change of this magnitude is difficult and takes time and support. A CC is one way to provide that support and to encourage the members to support each other. This is important in teaching any subject, and the tips listed here would help in the implementation of any CC. But it is especially important in statistics, since so many statistics classes are taught
by nonstatisticians. And while the main change we hoped our faculty would make is the transition from lecture-based to active learning, this method of change could be used for other large-scale changes across entire departments.

In the future, we plan to expand the use of active learning in introductory statistics. One issue that has arisen following the year detailed in this article is how to quickly bring new faculty up to speed on the application of active learning in their classrooms. We also want to spread this method of instruction to other colleges and universities. We are in the planning stages of a new project that would include another university. Course communities play a large role in the planned professional development.

References

Aliaga, M., Cobb, G., Cuff, C., Garfield, J., Gould, R., Lock, R., Moore, T., Rossman, A., Stephenson, B., Utts, J., Velleman, P., and Witmer, J. (2005), *Guidelines for Assessment and Instruction in Statistics Education: College Report*, San Francisco, CA: American Statistical Association.

Bonwell, C. C., and Eison, J. A. (1991), *Active Learning: Creating Excitement in the Classroom. ERIC Digest*, Washington, DC: ASHE-ERIC Higher Education Reports. ERIC Clearinghouse on Higher Education.

Cox, M. D. (2004), “Introduction to Faculty Learning Communities,” *New Directions for Teaching and Learning*, 2004, 5–23. DOI:10.1002/tl.129

Doerr, H. M., Goldsmith, L. T., and Lewis, C. C. (2010), *NCTM Professional Development Research Brief Mathematics Professional Development*, Reston, VA: National Council of Teachers of Mathematics, available at [http://www.nctm.org/uploadedFiles/Research_and_Advocacy/research_brief_and Clips/Research_brief_15-Goldsmith(1).pdf](http://www.nctm.org/uploadedFiles/Research_and_Advocacy/research_brief_and Clips/Research_brief_15-Goldsmith(1).pdf)

Freeman, S., Eddy, S. L., McDonough, M., Smith, M. K., Okoroafor, N., Jordt, H., and Wenderoth, M. (2014), “Active Learning Increases Student Performance in Science, Engineering, and Mathematics,” *Proceedings of the National Academy of the Sciences*, 111, 8410–8415.

Green, L., McCormick, N., McDaniel, S., Rowell, G., and Strayer, J. (2015), MTStatPAL.com, available at [https://mtstatpal.com/](https://mtstatpal.com/)

Green, L., McCormick, N., McDaniel, S., Strayer, J., and Rowell, G. (n.d.), Addressing Challenges to Implementing Active Learning for All Sections of Introductory Statistics at a Large University (in press).

Hamos, J. E., Bergin, K. B., Maki, D. P., Perez, L. C., Prival, J. T., Rainey, D. Y., Rowell, G. H., VanderPutten, E. (2009), “Opening the Classroom Door: Professional Learning Communities in the Math and Science Partnership Program,” *Science Educator*, 14(2), 14–24.

Kanter, R. M. (1985), “Managing the Human Side of Change,” *Management Review*, 52–56, available at [http://www.apbs.org/archives/conferences/fifthconference/files/UTAH/managing_Change.pdf](http://www.apbs.org/archives/conferences/fifthconference/files/UTAH/managing_Change.pdf)

Lewin, K. (1947). “Frontiers in Group Dynamics: Concept, Method, and Reality in Social Science; Social Equilibria and Social Change,” *Human Relations*, 1(1), 5–41.

Meyers, C., and Jones, T. B. (1993), *Promoting Active Learning. Strategies for the College Classroom*, San Francisco, CA: Jossey-Bass Inc.

Ohio Department of Education (2010), *Standards for Ohio Educators: Ohio Standards for Professional Development*, available at [http://education.ohio.gov/getattachment/Topics/Ohio-s-New-Learning-Standards/Mathematics/Math-Standards.pdf.aspx](http://education.ohio.gov/getattachment/Topics/Ohio-s-New-Learning-Standards/Mathematics/Math-Standards.pdf.aspx)

Prince, M. (2004), “Does Active Learning Work? A Review of the Research,” *JEE: The Research Journal for Engineering Education*, 93(3), 223–231.

Scheaffer, R. L., and Stasny, E. A. (2004), “The State of Undergraduate Education in Statistics,” *The American Statistician*, 58(4), 265–271.