Ten Myths of Cooperative Learning in Engineering Education

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Abstract - *The practice of using active learning as a teaching paradigm has been a mainstay of the K-12 community for a long time. Even with mounting evidence attesting to the efficacy of these techniques, college faculty have generally been slow to adopt interactive teaching methods.*

The authors have been involved in Project LEA/RN (Learning Enhancement Action/Resource Network) at Iowa State University, a program created and mentored by Dr. Barb Licklider whose goal is to provide training, resources, and encouragement to faculty members who want to improve student learning.

During our own induction into the program, and now as work group facilitators, we were surprised to hear faculty from different disciplines cite identical reasons why active learning wouldn't work in their classroom. Examples include: interactive exercises won't work in large classes; students will refuse to participate; there's no individual accountability when students work in teams; you can't cover as much material if you use an interactive approach, etc. In this paper, we will discuss ten myths of cooperative learning and how our Project LEA/RN groups were able to work through them one by one.

Introduction

In 1994, Drs. Barb Licklider and Howard Shapiro at Iowa State University started a program called Project LEA/RN with the goal of providing training, resources, and encouragement to faculty members who want to improve student learning by employing active learning techniques in their classrooms. Interested faculty commit to bi-monthly LEA/RN groups (workshops) where they learn and practice effective teaching strategies. Each workshop session provides a faculty member a new or refined strategy to try out in their next class. At the heart of Project LEA/RN is immersing participants in an effective educational environment to build strong, on-going support groups among faculty. An "effective educational environment," as defined by research on effective staff development, includes: the presentation of theory; opportunities for demonstration, practice, feedback, and coaching; and time to focus on the theories and skills being taught. Facilitators in an effective educational environment use, as well as teach, effective learning strategies and provide participants opportunities for guided practice of these skills. The strategies and skills are those gleaned from the lessons and research about effective staff development and interactive teaching including, but not limited to: student base groups (a key cooperative learning strategy), inductive learning, questioning, developing course and lesson objectives, colleague observation of teaching, and assessment. Rather than a one-time in-service training that has an immediate impact but little long-term effect, the model calls for regular meetings over an extended period of time for additional instruction and group support. Feedback is provided not only by the facilitator, but also by each other as learning partners observe each other's classrooms on a regular basis. Such an environment provides a safe, stimulating context in which to explore and test learning and pedagogical theories and their implications for effective teaching.

In this paper we use the terms *cooperative learning* and *active learning*. Cooperative learning as defined by Johnson, Johnson, and Smith [1] is: "Cooperative learning groups may be used to teach specific content (formal cooperative learning groups), to ensure active cognitive processing of information during a lecture (informal cooperative learning groups), and to provide long-term support and assistance for academic progress (cooperative base groups)." The term active learning is a broader term used to identify all activities that actively involve the students [3].

Myth #1: Cooperative learning won't be successful in a technical field

This is one of the most common myths we encounter, and is typically the first question asked at an active learning workshop. At first glance it seems to many that cooperative learning is best suited for non-technical subjects whose content is somewhat subjective. Our experiences have shown that cooperative learning does work in technical courses. We have used cooperative techniques in Engineering courses ranging from sophomore level through graduate level. Part of our success can be attributed to spending time setting the stage and building a sense of community among the students.

Dr Jacobson spends the first two hours of CprE 211 (a sophomore class in digital design) building a strong sense of community in the class. The students are engaged in an interactive activity within the first ten minutes of the first class. Students work in groups of three or four to address questions based on the theme: What is an Electrical or Computer Engineer? They answer the following questions as a group and write their answers on 25 x 30 inch post-it notes, placed on the wall in a gallery fashion to encourage discussion. Areas of discussion include:

What team skills are needed?

What technical skills are needed?

What type of personality does a CprE or EE have?

What job duties or functions does a CprE or EE have?

This exercise is designed to get students thinking about the course and their chosen discipline, and it introduces them to the philosophy of working in groups. It's explained to students that teamwork is essential to their success in the course and that class time will be used to build effective team skills. It's quite a sight to walk around the room and see 80 students engaged and writing on giant post-it notes on the wall. We also develop ground rules for the class during the first day. By the second class, we have divided students into groups of size four that will be used for in-class exercises as well as course projects and homework. A focus for the second class period is to have group members get to know each other better. We use a simple exercise where we divide groups into two pairs of students and develop a list of things in common and differences (using a Venn diagram). The two pairs then jointly develop a list of commonalties. This activity helps build community among the members of the group.

As we move through the semester and the interactive skills of the students improve, the groups work on course content-oriented exercises. Because the groups become a safe and supportive place, interaction between group members really seems to enhance learning. We have found that interactive exercises are well accepted by engineering students, and almost all students feel it helps them understand the course material.

Myth #2: If cooperative learning is used, there won't be time to cover important material

This is the next question we typically hear following our response to the first issue: "If you spend all this time working on building community, working on interactive skills, and working on team skills, when do you get to deal with the course content, and what content do you eliminate to fit the new material in." One of the biggest changes we made to our courses during the last year was the establishment of learning objectives. We reviewed our courses and determined what the students needed to know coming into the course and what we wanted them to learn during the course. We then developed a set of course objectives that were styled after those found in Pregent's book [2]. We discovered that about 10% of course material covered was not connected to a learning objective. We were also able to focus the course on a few key objectives that could be assessed and evaluated throughout the course. The objectives also have the benefit of providing students with a clear understanding of what we feel is important and what we will assess. Another aspect of this question is the difference between "covering material" and "learning concepts". Faculty often hear: "I know that material was covered in the prerequisite course, but the students don't know it." If we focused on the core competencies and provided the students with the tools needed to self-assess their progress toward learning those competencies, we would not hear that question. The bottom line is that there is less content "covered" in our courses, but we believe the students "uncover" the most critical concepts.

Myth #3: Students won't meet outside of class for base group meetings

One of the activities we use to help our students better learn the material and to help them work on teaming skills is to form base groups. A base group is typically four students chosen by the instructor either by random or using some other criteria. The base group meets outside of class to work on various assignments. Sometimes the base groups are used in class. When we first started to introduce base groups to other faculty members, we often heard that they can never get their students to meet outside of class. There are several key elements to creating effective base groups. These include justification for the groups, building a sense of community, giving them the right task, and making them accountable. We will briefly address these key elements.

Students need a clear justification for creating and using base groups. Time needs to be devoted to explaining the importance of the groups in terms of the class and their careers in general. Essential elements of an effective base group include building community and helping the students learn how to function as a group. While students may have had experience working with a partner in a laboratory setting, they often have had little experience functioning as a team member. We teach interactive skills students need to function in groups. We talk about what makes an effective group, even model good and bad group behavior. The group also needs to have time to get to know each other and to learn to feel safe as a group.

We have found that giving the groups the right kind of task is also critical. The most important characteristic is that the assignment must be worth doing (i.e., its educational benefits should be clear, ideally connected to a course learning objective). Many of our students have part-time employment, family commitments, or they commute to campus. We try to ensure that the time they work outside of class is worthwhile. The most common complaint from

students has been that the assignment was best done individually and not as a group. We address this by designing the exercise so that it can be partitioned within the group. During a recent mid-course survey where students were asked to comment on base groups, the majority of comments were very positive; in fact most students wanted more base group homework.

The last key element of an effective base group is to make the group accountable for achieving the desired outcome, but make the members individually accountable for their understanding of the solution and their participation. Simply put, the students will do the work if they are held accountable. More important is that they will take pride in their work as they know you will look at it and provide feedback. We have found that students like to demonstrate what they know.

Myth #4: College students don't want to learn interactive skills

When we tell faculty members that we actually teach social skills to college students, their first reaction is disbelief followed by comments that students don't need or want to learn these skills. We have found that these skills need to be taught in a certain way to make them more effective for college students in a technical course. Exercises where we model interactive skills work better if it is in the context of the course material, or is used in the middle of a class period to break up the time. For example, we teach staying on task in a sophomore level course by modeling bad behavior in the context of the course material. They were told we were going to work on group roles and that each member of the group would be assigned a role. Then, the group would work together on a problem based on the course material. Group members were assigned roles with two of the members secretly instructed to keep the group off task. We let this activity proceed for a couple of minutes until it looked like most people either caught on or were getting frustrated. The activity was then stopped, and we discussed (processed) the activity and talked about staying on task. We completed the exercise by having the group reconsider the original question, only this time functioning as a normal group. In this case, experiencing and processing the interactive skill required only about 10 minutes. Teaching of the interactive skills and the student's response again goes back to the faculty creating a safe environment and setting the expectations early in the class.

Myth #5: Students don't want to work together

It is often said that “good students” don’t want to work in groups. We do see some initial reluctance to group work by a few students, primarily because they have not had positive experiences. The key is to set up an evaluation system that does not harm the students. Dr. Licklider is fond of saying, “first do no harm”. As an example, it would be unfair to high achievers if we team them with low achievers and then give everyone in the group the same grade based on their combined performance. It is essential that each group member be individually accountable for all portions of the assignment. If we design our group work using that as the overriding premise, then students are more willing to work in groups. Again, if a faculty member spends time building community and providing a safe learning environment, students will want to work together. As discussed, it is critical to find a good problem for them to work on in a group. For example, we have tried to have students write programs in class as groups. If the program is anything more than a few lines of code, the group activity tends to fail. Because program styles vary between students, it is difficult for them to synthesize a solution in a short period of time as a group. An example of a good group problem is one that can be divided into pieces do that each group member contributes his/her own ideas to the solution.

Myth #6: When students do work together you can't tell who is doing the work

The issue of individual accountability is often used as a reason for not doing group work. There are at least two issues that can be addressed with respect to individual accountability. The first is summative evaluation and the need to assign a grade based on individual performance. There are many well-known ways to evaluate a student's individual performance including exams, quizzes, and homework [4]. Where we spend most of our efforts is in assessing the progress of the student and trying to determine if they are learning the material. Accountability is one of the key components of the interactive strategies we use in class. If the students (either individually or as a group) are not accountable for their work, then they will not put as much effort into it. Part of that is due to “making them work”, but we believe a bigger part is that it shows you care about what they produce. We found that students like to show what they have learned. During in-class exercises, you can assess a student's participation in an activity by walking around the room and observing the group interaction. This helps get you involved as well. The base groups keep minutes of the group meetings and make comments about how the group has been functioning. This helps identify potential problems in the groups and will create individual accountability with in the groups.

Myth #7: Cooperative learning can't be done in a large class

This myth does have some truth to it. We have better (i.e., more personal) interaction in a class of 20 students than in a class of 80, however we have been able to use most of the interactive strategies in class sizes of 70 to 80. We also

believe that the larger class benefits most from interactive. One does need to adjust methods when handling larger classes. The biggest problem comes with accountability. In a small class you can typically call on every student or every group during an exercise. With a class of 80 one typically cannot call on every group every day. What we have done is to call on groups by row in the room, so that every group a change to answer a question during the class period. We have had several students make positive comments about calling on groups by row. Another problem is that building community takes longer in a large class, but the payoff for succeeding is high. It is very rewarding to see a room of 80 students in groups engaged in an interactive exercise. You can see and feel the learning taking place, and the students are having fun!

Myth #8: Cooperative learning means no lecturing

After going through the first year of cooperative learning training, we began to attach strong negative connotations to the word "lecture". We fought hard not to even use the word. We have since come to a realization that we still need to lecture and the act of lecturing is not bad. We need to create a balance between lecturing and interactive activities. This balance will change from day to day. Some days, the primary mode of delivery is the lecture with several small interactive exercises mixed in to keep the students engaged. There are also times when the entire session consists of interactive exercises designed to further understanding of a set of objectives. We are, however, always looking for ways to use interactive strategies for presentation of new materials.

Myth #9: Cooperative learning doesn't impact learning

Because we lack control groups for classes using cooperative learning, it is difficult for us to quantify improvements in learning. We do, however, have some evidence that the students have an increase in learning coupled with a strong positive attitude about the course. For example the CprE 308 course taught by Dr. Davis uses material taught in the CprE 211 course taught by Dr. Jacobson. Dr. Davis has started to notice an increase in the abilities of the students in the areas covered by the 211 course since active learning was introduced. We have also noticed higher test scores from the middle range students and a deeper understanding of the material. We believe that student-centered learning has made a difference in the way our students work in class and in the level of learning that takes place. The attendance rate is higher when classes routinely include interactive activities. Another side effect of this method of teaching is an increase the student participation in class. The students will ask more questions and will engage in dialogue as a result of building the safe environment. The feedback we get from class surveys and questionnaires indicate the students prefer an interactive to a non-interactive class. One other side effect has been an increase in the teacher evaluation numbers at the end of the semester.

Myth #10: Cooperative learning can't be done in graduate classes

Drs. Davis & Jacobson both use cooperative learning in their graduate classes. We both use base groups in our classes, and we use interactive exercises to assess learning and to have the students synthesize new knowledge. We often pose a problem before we have covered the material to see how well they can create a solution; often we discover they have a better understanding of the material than we first thought. We also use these exercises to address social and ethical issues that are difficult to lecture on.

Myth #11: It takes longer to prepare for class

We needed one myth that was true. Yes, it does take more time to prepare for a class. We probably should not admit this, but before cooperative learning we often could deliver a lecture on a given topic with a single page of notes. Now we find ourselves planning the course period and trying to decide what strategies to use and how to assess the student's learning based on our purpose for the class. One thing that has helped us is that we bounce ideas off of each other and support each other when we try new exercise. The Project LEA/RN staff also provide a good support mechanism to help with new things. When Dr. Jacobson first tried a community building day with his class of 80 a member of the LEA/RN staff came to observe. It is this peer observation and support structure that help us get through. There is some hope, however, for reducing class preparation time. As we do more activities, they become more natural and easier to insert into the class. Also, by keeping a log of what works and what does not work, it takes less preparation the next time the course is taught.

Conclusions

In this paper, we discussed ten myths of cooperative learning and how we were able to work through them one by one. These myths are often presented as the truth and as reasons to not try something new. The authors have tried to dispel the myths using their own experiences in the classroom.

Our participation in Project LEA/RN over the past 2 years has completely changed the way we teach our classes, the way we interact with students, and the way we view teaching and education. We have just briefly outlined some

of the concerns we have encountered during our evolvement with Project LEA/RN as seen from the perspective of two engineering faculty members. We have shown that faculty can, through the help of professional educators, make changes in way students learn. We have also shown that with support we can help faculty see through the myths and make a difference in students learning. We truly believe that more of our students are learning the material at a higher level.

References

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