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Collaborative Learning Strategy in the Classroom: The Progressive Peer Group

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A peer-interaction strategy was developed to maximize meaningful small-group work interactions with students in the class, modeled after a progressive dinner. A progressive dinner is a meal in which participants travel to different locations for each course, thereby interacting with many more people in an intimate setting than they otherwise could in a traditional dining scenario. This paper discusses a collaborative learning strategy developed for a dynamical systems class using largely the same concept: students move around in groups to solve different problems. This technique was used for a dynamical systems class to 1) help students gain familiarity with key concepts, 2) give the instructor an opportunity to correct misconceptions in-class, 3) expose students to multiple instances of the same concept to promote pattern recognition in the class, and 4) promote peer learning for each student.

Students were assigned randomly into groups of 3, and each group was given one of 4 similar problems. The group worked collaboratively to solve a problem reinforcing concepts discussed in class. The instructor assigned a number to this group's problem, which was then referred to as the home problem. After solving the home problem, the group was dispersed. One member would move to the next problem up, another would move to the next problem down, and the third would stay with the original problem to serve as a peer mentor to the two new students arriving to the group. After solving the new problem, every student moved to the next problem up. That meant that one student from the original group rotated back to the home problem. After working the new problem, every student moved to the next problem up unless they hadn't yet mentored, in which case they moved back to their home problem. At the end of this exercise, every student in class had solved three different problems, and had been a mentor for one problem.

Minor modifications were made for times when the class wasn't divisible by three. For a class with reasonable confidence on the subject, a group of two was assigned, with the understanding that there may not always be a mentor sitting at the group of two's station for every rotation. The instructor kept a closer eye on that group for additional guidance as needed. For more challenging subjects, a group of four was put together, and two students rotated through the stations together.

Several assessments were conducted to investigate the efficacy of the progressive peer group. The progressive peer group was used for inverse Laplace transforms, but not Laplace transforms. Both topics were covered as part of a lecture, had assigned homework problems, and were covered in the exam review. Student exam question grades associated with both topics were graded and compared. Despite the inverse transform being typically more challenging, students performed statistically significantly worse with the Laplace transform. Differences in performance were also measured for sections offered the progressive problem for different topics.

Introduction:

STEM education has shifted toward an active classroom, recognizing that significant learning occurs with an engaged student (1). An active classroom can be used to give students practice with a concept or procedure, and using peers collaborative partners, all while the instructor monitors to correct misconceptions and address points of confusion. This paper discusses a progressive peer group strategy, an intervention where students work in multiple groups over the course of a classroom to solve several different problems collaboratively and to get experience working with a peer tutor as well as to function as a peer tutor. The structure of the progressive peer group and variations are discussed in the Methods section, and the experimental outcomes of such an academic intervention are in the Results and Discussions section.

Background:

Educational psychologists have found that for students to learn science, they must be presented conflicting ideas and provided a social context in which to set these new thoughts. That is, they must use terms and conventions with others (2). Learning in groups can assist with the socialization inherent in that activity. This has led to a shift in the STEM world from lecturer-centered teaching to a focus on student-centered learning, and in particular a more active learning classroom (1). Students who believe they are active participants in a classroom are more likely to believe that an instructor views their questions and interactions as positive (3). In fact, in a study across six universities, students who were in active learning classrooms increasingly saw learning as a collaborative process, and had increased interactions with faculty (4).

One form of active learning is the collaborative learning model, where students work together to complete an educational task. Collaborative learning has been found to contribute positively toward learning (5), as well as improve their peer-to-peer working relationships and individual self-esteem (6). Students engaged in collaborative learning have been found to be more comfortable working with that format, and believe that it benefits their learning (7). Students participating in instructor-assigned work groups that are reassembled regularly to align abilities show improvement over students not provided those treatments (8). In fact, external collaborative learning study groups have been found to dramatically decrease DWF rates, particularly among underrepresented minorities (9).

Methods: Implementing the Progressive Peer Group

The intervention, known as the progressive peer group, derives its name from the progressive dinner party. During a progressive dinner party, three to four hosts invite participants over for a course of a meal. Participants rotate from location to location, eventually consuming an entire meal. The idea behind a progressive peer group is that there are many problems for students to work, and each student throughout the course of a fifty minute class will work three problems and "host" a problem as a peer tutor. In class, these progressive peer groups are called "Funky Fridays"; they were implemented on a weekly basis as a way to practice the topic(s) of the week. The name gave the cue that this was a regular, ongoing expectation.

The progressive peer group is implemented as follows: the instructor prepares at least four different problems for students to work. Students are randomly grouped in threes and assigned an exercise to work. Playing cards are an easy way to help direct students to minimize time lost during moves, and are an easy way to continually mix students into new groups. One suit, clubs for the purpose of this paper, are always assigned to the problem, and students are originally assigned to work the problem with the same face number (ie: all students with a “3” work at the club-of-3 problem). After students have worked those problems successfully on their own notebook paper, they switch groups. Students with hearts rotate to the next problem up; those with spades rotate to the next problem down, and diamonds stay with their own problem. The diamond students now become tutors for the two new students coming to work the problem.

Students rotate twice more, and this ensures that each student works three different problems and is a learning coach once. After the diamonds have become the learning coach, everyone rotates one group up. This means the spades have rotated back to their original problem, and are now the learning coach. After that problem has been worked, everyone rotates up one more problem except for hearts, who move back to their original problem to be tutors.

At the end of class, each student has worked with five other peers, had three opportunities to work on problems with other students, where two opportunities involved learning from another peer, and one opportunity to help teach his or her peers. It is important during this whole process that the instructor sets expectations at the beginning of the class, perhaps providing a visual aid at the front of the room, or a brief reminder of concepts that are relevant to the problem solving. The instructor must be available to answer questions, correct misconceptions, and contextualize and summarize activities at the end of class. After class, the instructor should post the original problems and solutions to all class problems.

It is important to note that the original group needs much more time to work the problem then subsequent rotations. The first group might be expected to work on their problem for 15 minutes, a second group may take only 11 minutes, a third down to 9, and then the last group would last 8 minutes. The first group takes the longest because no one is familiar with the problem and they must all work through it together. For the second problem, there is a peer tutor who can usher students past stuck points. With the third and fourth iterations, the students start to see the patterns in the problems, even if they address different case studies, and so it takes yet even less time. The tutor is, by the time of the third and fourth rotation, also familiar with some of the differences, so can quickly point out how this particular problem differs from the other cases.

One challenge with this method is addressing common anxieties among students, such as: 1) they may work and record the wrong solution, and 2) they didn’t get to work all the problems. By posting the original (unworked) problems and solutions, they are able to compare what they did to the correct version, and then have an additional problem to try. The introduction and conclusion talks can also help give students confidence that they have the tools to solve these problems, and that they have taken a meaningful learning experience from the class. Conclusions usually are discussions where the instructor asks for students to comment on commonality between the problems, useful techniques, and to gage if more practice is needed on a topic.

Another challenge of this method is that to engage in this methodology, not all material that would be covered by strict lecture can be covered when implementing a progressive peer group. The author approached each class topic with questions such as: what are the most important points? What do students most need to see modeled, and which material will they likely be able to stretch a little bit to understand in peer format? Derivations were often relegated to complemental videos posted to the course management systems, but announced in class ("The impact-momentum principle comes from Newton's second law and kinematics; I've posted a video on the LMS for those who are interested in that derivation"). Generally there can only be time for one or two examples, thus not all example conditions can be covered in lecture-format. For example, solutions to a second-order linear time invariant differential equation may work problems that are overdamped and underdamped, but not have time to go into the critically damped scenario in detail. For these situations, the instructor simply mentioned there is a third case, gave a brief overview as to how it differs from the other two cases, and gave a few helpful hints about how this might be applied. That being said, cases not covered in class are definitely included in the homework and the peer-learning treatment so that students are still exposed to and engage with those concepts.

Finally, as with any new method applied in a classroom setting, it is important to monitor student learning closely. Minute papers at the end of class can be used to great effect. Short polls, either through clickers or even thumbs-up/thumbs-down are great ways to monitor progress through an intervention problem. Discussions about similarities and differences between the problems can help the instructor identify the types of connections students have made, and where they may need more work. Students readily offer feedback about the relative challenge of individual problems ("The A-problem was just like the example, but man, that B problem was wild!")

If, with careful monitoring, student learning is not going as planned, the instructor must be prepared to deviate from the previously planned progressive peer group. Variations on this method that the author has invoked include: having the entire class work on one problem together, nominally in groups of threes, but coming together as a class to work through the challenging portions and discuss ideas on how to proceed. The author has also stopped progressive peer work to bring the entire class together to discuss a concept if it is clear there is wide-spread confusion or misconceptions. There have been times where there is no class rotation; everyone just works with their original group of three to learn from the problem. While the intervention may be modified in response to learning needs, it is strongly recommended that the instructor brings the whole class together at the end to summarize and contextualize the day's activities.

Results and discussion:

The progressive peer group was instituted in two sections of a junior-level systems dynamics course on an approximately weekly basis ("Funky Fridays"). Students were surveyed at the end of the semester and their observations on the intervention were noted. The main results come from a particular topic in which students were given disparate treatment.

Students in two sections of a systems dynamics course reviewed both Laplace transforms and Inverse Laplace transforms, specifically how to find solutions to linear time invariant homogeneous differential equations given initial conditions using Laplace transforms. Given the limited instructional time, the instructor administered an intervention for inverse Laplace transforms, as that process is slightly more complicated than for a Laplace transform. Following the intervention, students were assigned homework to practice both Laplace and inverse Laplace transforms. During the student-led exam review (as in, students request which topics are discussed) there were overwhelmingly more requests for Laplace transforms as opposed to inverse Laplace transforms, by a 2-to-1 margin. During the exam, students were asked to perform one Laplace transform of a second-order LTI differential equation and one inverse Laplace transform. The difference was startling: students performed on average 24% better in inverse Laplace transforms than in Laplace transforms. Table 1 shows the performances of each exam, in which 61 students participated. The exam questions are located in the Appendix.

Table 1: Means and standard deviations for the Laplace transform and inverse Laplace transform exam questions

	Laplace Transform Question	Inverse Laplace Transform
Mean, %	79.8	55.3
Standard Deviation, %	31.0	37.8

Following these outcomes, an additional Funky Friday was performed; here, students practiced Laplace transforms as a remediation. During the final exam, students were asked to perform a Laplace and inverse Laplace transforms. For the final exam, there was no statistically significant differences between the two outcomes. There are a few interesting observations here:

1) engaging in group work as described here seemed to sensitize students to their own limitations with respect to the subject, as evidenced by the increased questioning during the exam review, and

2) covering topics in this peer-learning approach improved short-term learning outcomes, as evidenced by contrasting performances in the first exam, and the consistent results in the final exam.

On an observational side, students were surveyed twice during the semester regarding the execution and perceived efficacy of the treatment. The results were not preserved, sadly, though the overall feedback was positive. For final course reviews, there were six mentions of the treatment, five of which were positive. The sixth preferred a pure lecture format. Students in general felt the instructor was more responsive and enthusiastic than evaluations in previous semesters, which would be consistent with findings from research (3).

Conclusions:

A collaborative learning treatment was applied to a junior-level systems dynamics course for mechanical engineering majors. The treatment was structured such that all students had a turn to behave as a peer tutor/teacher, and was a learner first with a study group of three, and then later as a tutored student twice. Exam results indicate that this treatment improved students learning. Student evaluations reveal generally positive attitudes toward the intervention.

References:

1. *Impact of Undergraduate Science Course Innovations on Learning.* **Maria Araceli Ruiz-Primo, Derek Briggs, Heidi Iverson, Robert Talbot, Lorrie A. Shepard.** 6022, March 11, 2011, Science, Vol. 31, pp. 1269-1270.

2. *Constructing Scientific Knowledge in the Classroom.* **Rosalind Driver, Hilary Asoko, John Leach, Eduardo Mortimer, Philip Scott.** 7, s.l. : Educational Researcher, October 1994, Vol. 23, pp. 5-12.

3. *Students' perceptions of their classroom participation and instructor as a function of gender and context.* **Gail Crombie, Sandra W Pyke, Naida Silverthorn, Alison Johes, Sergio Piccinin.** s.l. : The Ohio State University Press, 2003, pp. 51-76.

4. *Reform in undergraduate science, technology, engineering and mathematics: the classroom context.* **Frances K State, Jillian Kinzie.** 2, 2009, The Journal of General Education, Vol. 58, pp. 85-105.

5. *How to increase the benefits of cooperation: Effects of training in transactive communication on cooperative learning.* **Suzanne Jurkowski, Martin Haenze.** s.l. : The British Psychological Society, 2015, British Journal of Educational Psychology, Vol. 85, pp. 357-371.

6. *Cooperative learning returns to college.* **David W Johnson, Roger T Johnson, Karl A Smith,.** 4, Jul/Aug 1998, Change, Vol. 30.

7. *Student learning and perceptions in a flipped linear algebra course.* **Betty Love, Angie Hodge, Neal Grandgenett, Andrew W Swift.** 3, 2014, International Journal of Mathematical Education in Science and Technology, Vol. 45, pp. 317-324.

8. *Active learning strategies in the analytical chemistry classroom.* **Michael R Ross, Robert B Fulton.** 2, February 1994, Journal of Chemical Education, Vol. 71, pp. 141-143.

9. *Peer-Led Team Learning Helps Minority Students Succeed.* **JJ Snyder, JD Sloan, RDP Dunk, JR Wiles.** 3, March 9, 2016, PLoS Biology, Vol. 14.

Appendix: Exam Questions:

Laplace Transform Question:

> "A mass-spring-damper system is known to behave according to the differential equation: $2\ddot{x} + 4\dot{x} + 5x = 0$. If the initial conditions are $x_0 = 1, \dot{x}_0 = 0$, find the expression for the Laplace transform $X(s)$."

Inverse Laplace Transform Question:

“Pretend the Laplace transform [from the previous question] is $X(s) = \frac{3}{s^2+7s+12}$ (it’s not). Find $x(t)$.”