Testing Jigsaw Learning Against a Traditional Lecture

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Abstract:
Oppenheimer said "The best way to learn is to teach."[1] Mazur found that "Nothing clarifies ideas better than explaining them to others."[2] Using this philosophy, Jigsaw Learning,[3] is a peer-to-peer teaching method developed by Elliot Aronson in which every student teaches something that they have learned from one study group to another group of students. During class, the faculty breaks a course topic into different assignments and the class into the same number of study groups. The study groups each contain an equal number of students. Each group is given an assignment to read, discuss and finally decide how they will serve as instructors on their topic. The faculty visits each group to discuss the topic and answer questions. After this study period, new jigsaw learning groups are formed that contain a representative from each of the original study groups, thereby bringing all of the course topics together in one group. Each representative is asked to instruct their group on what they have learned. The groups are then disbanded and the class is reunited for review and to answer remaining questions in order to guarantee correct understanding.
The goal of this paper is to test Jigsaw Learning against a traditional lecture as a teaching technique on the same topic for freshmen Architecture and Construction Management students who have been benchmarked using a prior test. The test group is given the Jigsaw Learning method, while the control group is given a lecture on the same topic. The timeframe for the exercise is the same for both groups – i.e. one hour of a class that is nearly 3 hours in duration – and immediately following, both groups were given the same test on the topic. The results of this study will provide faculty with an understanding of the relative benefit of the initial implementation of Jigsaw Learning into their courses.

Introduction:
The goal of this paper is to quantitatively and qualitatively test the traditional lecture against an active learning, peer-to-peer teaching method called Jigsaw Learning that the author implemented for the first time early in the fall semester of 2011, in a freshman Materials and Methods of Building Construction I class.
In 1987, Thielens stated that 89% of U.S. professors lecture as a mode of instruction.[4] The current number of professors who lecture as the only mode of instruction, those who supplement lectures with active learning or those who only use active learning is unknown. Research has shown that students must do more than just listen to truly learn.[5] Surveys of learning styles have shown that 65% of our student population are visual learners, 30% auditory learners and 5% kinesthetic learners.[6] This may be true but there is more to teaching than presenting visuals. One type of visual presentation commonly used is the PowerPoint lecture, incorporating slides. It has been found that when lectures are turned into PowerPoint presentations, students cannot keep up writing their notes and if copies of the PowerPoint slides are distributed, students have little incentive to go to the lecture.[7]

In a previous study the author tested the active learning task of student-sketched lecture diagrams against students who passively looked at the same diagram on a handout. The active group achieved on average a 20% higher score than students who passively looked at the same diagram

on a handout.[8] Active learning according to Felder and Brent is "anything course-related that all students in a class session are called upon to do other than simply watching, listening and taking notes."

Cooperative Learning is a collaborative active learning technique where students are placed into interdependent teams of 3 to 5 members and assigned a structured task such as "multiple-step exercises, research projects, or presentations."[9] Per Johnson et al there are 5 crucial components for cooperative learning groups:[10]

a. positive interdependence between students ("all for one and one for all")
b. face to face interaction
c. individual accountability
d. emphasize interpersonal and small-group skills
e. processes must be in place for group review to improve effectiveness

Ledlow adds that equal participation is also important: "the structure of the assignment should be such that all students have to participate, and that there are mechanisms to ensure that the participation is fairly equitable. You may try assigning roles, adding steps to the lesson that require input from all team members, or establishing turn-taking procedures.[11]"

Per Kohn, cooperative learning emphasizes that students can learn together instead of against each other and that it works with all grade levels, all student abilities and in subjects such as "math and science, language skills and social studies, fine arts and foreign languages.[12]"

Jigsaw Learning:

Jigsaw Learning is a cooperative learning technique invented by Elliot Aronson in 1971 in Austin, Texas, to help to diffuse tension in the city's classrooms after desegregation. Aronson and a group of his graduate students observed destructive competitive behavior amongst the white, African-American, and Hispanic children who were being taught together for the first time in a fifth grade classroom. Aronson and his team implemented their "Jigsaw" strategy in a random number of classrooms, which used jigsaw learning for a small portion of class time for 8 weeks. They then tested the jigsaw classes against the traditional classes. The following are their general findings.
"Jigsaw students:

1. Expressed less prejudice and negative stereotyping
2. Were more self-confident
3. Reported liking school better than children in traditional classrooms.
4. Were absent less often than were other students
5. Showed greater academic improvement; poorer students in the jigsaw classroom scored significantly higher on objective exams than comparable students in traditional classes, while the good students continued to do as well as the good students in traditional classes."[13]

Per Robert Half, 'When one teaches, two learn." With Jigsaw Learning, every student teaches something[14] (their assigned topic – a.k.a. their 'jigsaw piece') to their jigsaw team after they

have read, questioned and discussed their topic in an "expert group" of different classmates. The Jigsaw Learning procedure is explained in the Methodology section below.

Reasons for Choosing Jigsaw Learning for this Study:

The author is a recipient of a Title III Students First Grant for engaging pedagogy and first-year programs, and this is their first time using and testing the Jigsaw Learning technique. This learning technique was chosen for the following reasons:

1. To ascertain the relative benefit of using a peer-to-peer active learning technique with a first semester freshman class.
2. To encourage students to communicate, provide teamwork practice and encourage learning techniques for self-directed continuing professional development − all of which are criteria of the "Program Outcomes for Engineering Technology Programs" by the *Accreditation Board for Engineering and Technology* (ABET)[15] and part of the American Society of Engineering Education (ASEE) Green Report – "Engineering Education in a Changing World."
3. To add variety to a nearly 3 hour lecture class that does not have a laboratory component beyond soil sieve testing, thus helping to maintain the student's interest.
4. The author has successful used other active learning methods such as student-built physical models, student-produced visual dictionaries, and service learning, and is interested in finding other teaching methods to enhance lectures. Per Michael Prince – "Nonstop lecturing produces very little learning."[16]

Methodology:

"Per Dietrich: "A Jigsaw requires more preparation by instructor and student than an informal study problem. The instructor needs to design the cooperative learning task appropriately, and the students must prepare outside of the class. The in-class discussion puts the puzzle together."[17]

Two sections of Material and Methods of Building Construction I freshmen Architecture and Construction Management students were given the same pre-test on introductory wood topics in the fall of 2011. The pre-test results showed that both groups had an equal lack of knowledge of this topic and provided a benchmark for the post-test. The author gave the control group (n=12) a one hour lecture on the properties of wood and lumber. The second section of this course (n=25) was given the same course material as a Jigsaw Learning exercise which was conducted as follows:

1. The faculty informed the class that they will be working in teams and each member is responsible for their own individual section and for their group's success in presenting a topic.

2. The faculty divided each of the following into the same number of segments: the material to be learned, the class into groups and each group. The course topic an introduction to the construction material wood – was divided into 5 segments, and the class of 25 students was divided into 5 heterogeneous groups each containing 5 students. (It is more constructive for the faculty to select diverse teams with up to a maximum of 5 members rather than permitting the students to form their own teams.)
3. The faculty informs the class that there will be a test at the end of the jigsaw time period. This ensures that the students are more attentive and that they know that their work really counts.
4. Each group is assigned a different segment to read/problem solve from their textbook or literature provided by the faculty. They become "experts" in this topic through study, discussion and sharing ideas on how they can present their topic to others.
5. The faculty visited each group, answered and asked questions to ensure the students understood their topic segment and the exercise and the faculty made presentation suggestions.
6. Each "expert" group member was then assigned a number from 1-5 and the "expert" group is disbanded at the end of the set study/discussion time.
7. All students with the same assigned number formed a new group – the Jigsaw Group. Therefore all #1 students were together, all #2 students were together and so forth. There were now 5 new groups that each contained 1 "expert" in each of the 5 learning segments.
8. Each group member taught their learned topic to the other group members and they are in turn taught by their peers. Therefore, each group member shared their course topic segment of the 'jigsaw puzzle' and learned from their peers. This completed a coherent group 'jigsaw' of the course topic.
9. Faculty visits each group and encouraged team members to ask questions, write notes, draw diagrams and interact.
10. After each student had completed their teaching assignment and there had been enough time for discussion within the groups, the students returned to their individual seats and the test was given on the complete topic.

After both the test group (traditional lecture) and the test group (Jigsaw Learning) were given a post-test. The post-test had the same questions as the pre-test to ascertain what the students had learned during each section of class.

Quantitative Results:

Traditional Lecture		
Student No	Pre-test	Post Test
1	1	10
2	2	10
3	0	5
4	1	8
5	2	9
6	0	10
7	2	8
8	2	9
9	4	7
10	8	10
11	1	6
12	1	9
mean	2.000	8.417

Level of Significance for a Directional Test				
0.05	0.025	0.01	0.005	5E-04
Non-Directional Test				
--	0.05	0.02	0.01	0.001
$z_{critical}$				
1.645	1.960	2.326	2.576	3.291

Jigsaw Learning			
	Student No	Pre-test	Post-test
	1	0	6
	2	1	8
	3	2	3
	4	2	6
	5	2	3
	6	2	4
	7	2	9
	8	0	1
	9	3	5
	10	3	6
	11	2	7
	12	3	3
	13	0	4
	14	3	6
	15	3	5
	16	4	7
	17	4	6
	18	5	5
	19	3	5
	20	1	3
	21	3	8
	22	2	5
	23	2	5
	24	8	5
	25	2	7
	mean	2.480	5.280

Qualitative Results:
The following are the results from a short survey given to the Jigsaw Learning group:

Jigsaw Learning Survey Results	Strongly Disagree	Disagree	Neither Agree or Disagree	Agree	Strongly Agree	Total # of Responses	Average Result	Average Result
Question	1	2	3	4	5			
I learned more working in teams than in a traditional lecture	1	11	8	5		25	2.68	Neither
I enjoyed sharing what I learned with my team		1	12	12		25	3.44	Neither
I would like part of my class time to be team based		4	9	10	2	25	3.4	Neither
Working in teams allowed me time to get to know my classmates.		2	6	14	3	25	3.72	Agree

I learn more in a class that is mainly:	
Traditional lecture/note taking discussion	6
PowerPoint lecture/note taking/discussion	15
Studio problem solving w/short lecture/discussion	4
Other	0
Total # of responses	25

Discussion:
The results of the quantitative is test indicate that the magnitude of z scores is greater than z-critical for confidence levels through 0.001. The lower average score for jigsaw learning group is statistically significant. This finding is similar to that of Thompson et al in 1998 and Slavin[xviii] in 1995. The Thompson et al paper titled "Cooperative Learning Versus Traditional Lecture Format: A Preliminary Study" states: "The results failed to document any significant differences in the scores of students taught by the lecture method versus students taught by Jigsaw."[xix] Slavin found that students have limited exposure to the topic material that their team members are responsible for, so "learning gains on their own topics may be offset by losses on their group mates' topics." A separate study by the Johnsons found that the reward of group grades (based on the average of all group member individual scores) increased the achievement

of Jigsaw Learning.[xx] In another study, teambuilding activities alone had no effect on the achievement outcomes of Jigsaw Learning.[xxi]

The results of the qualitative test show that students in this study did not report benefits from the Jigsaw Learning activity beyond getting to know their classmates, which may increase their sense of community. The students' belief that they had not learned as much in the Jigsaw classroom activity was made evident by the results of the post-test above. Their negative response to active interdependent group work is also reflected in their majority vote for PowerPoint lectures – a largely passive exercise unless the faculty incorporates active questioning and problem solving within their presentations.

Conclusion:

The Jigsaw Learning activity described in this paper was performed in the third week of a freshman class. While this activity appeared to succeed as an "ice breaker" for the students, it failed in student retention of subject matter. This outcome, as reflected in the quantitative results, is largely based on the fact that the Jigsaw groups did not function as efficiently as a faculty member in teaching the set topics. Further research on this topic with larger sample sizes, the implementation of group grades as an incentive, and using Jigsaw Learning as a review method instead of an introductory method for new material is suggested.

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