RedFame

Journal of Education and Training Studies
Vol. 2, No. 2; April 2014
ISSN 2324-805X E-ISSN 2324-8068
Published by Redfame Publishing
URL: http://jets.redfame.com

Group Selection and Learning for a Lab-Based Construction Management Course

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Received: December 29, 2013 Accepted: January 14, 2014 Online Published: March 18, 2014

doi:10.11114/jets.v2i2.307 URL: http://dx.doi.org/10.11114/jets.v2i2.307

Abstract

In construction industries' projects, working in groups is a normal practice. Group work in a classroom is defined as students working collaboratively in a group so that everyone can participate on a collective task. The results from literature review indicate that group work is more effective method of learning as compared to individual work. However, only limited studies reported influence of group selection method on the learning of groups. To fill the gap in this area, the main objective of this study was to find out which selection method is the best to use and helps students to perform better in the course. Therefore, a total of three group selection methods, namely, random-selection by instructor, performance-based-selection by instructor and individual-selection by student were utilized. The target subjects used in the proposed study were students enrolled in two different lab-based construction management courses. The learning of each group was evaluated by calculating an average of scores received by all fellow members in the corresponding lab projects. Additionally, at the end of the semester, students were asked to complete a questionnaire. Data from all the questionnaires was also used for evaluating influence of group selection method on learning of students.

Keywords: Individual-selection, performance-based-selection, random-selection, group selection, group learning

1. Introduction

The concept of group learning has been widely advocated as a superior pedagogy over individual learning (Rau and Heyl, 1990; Gokhale, 1995; Timpson and Bendel-Simso, 1996; Barak and Maymon, 1998; McKeachie, 2002; Gunderson and Moore, 2008). The group learning term is a synonymous term with collaborative learning, cooperative learning, peer learning, and group work (Gunderson and Moore, 2008). The term "group learning" refers to an instruction method in which small numbers of students with complementary skills work together toward a common purpose for which they hold themselves mutually accountable (Gokhale, 1995; Barak and Maymon, 1998). In the field of construction management, ability to work in groups is a major component of a successful project. Group work in the classroom is way to enhance productivity of students through empowering higher levels of thoughts, facilitate participation in decision-making, and retain information longer than students who work quietly as individuals (Meyer, 1994). The group learning trains students for similar experiences in the construction industry upon graduation.

Although several studies compared group and individual learning, only limited studies reported influence of group selection method on the productivity of students. Also, majority of the research in group learning has been conducted in non-technical disciplines. To this end, the current study was conducted to fill the gap in this area by evaluating productivity of a lab-based construction management class groups selected using different methods.

2. Literature Review

Previous research showed that group learning fosters socio-emotional benefits from inter-personal relationships, critical thinking through discussions, and often greater academic success (Cohen, 1994; Bartlett, 1995; Gokhale, 1995; Gunderson and Moore, 2008). According to Totten et al. (1991), the collaborative learning gives students an opportunity to take responsibility of their own learning, engage in discussions, and thus become critical thinkers. Cohen (1994) showed that group work manages academic heterogeneity in a classroom with a wide range of academic achievements. Qin et al. (1995) compared the impacts of cooperative versus competitive learning on problem solving. It was found that members of cooperative groups outperformed individual competing with each other on different types of problem solving. In a technological task study, Barak and Maymon (1998) identified four aspects, namely, common goal, composition of group, decision-making, and team development, of group learning.

However, few studies identified negative aspects of group learning. One problem is failure to contribute by all the group members, also known as "freerider" problem (Bartlett, 1995; Blumenfeld et al., 1996). Additionally, anti-social behavior can occur when forceful students dominate or force conclusions on a group. Others may ridicule and exclude group members or discount their contributions leaving those rejected members to feel humiliated or withdraw from the group completely (Blumenfeld et al., 1996). The aforementioned aspects can negatively impact the productivity of a group. The anti-social behavior in a group can be reduced through management techniques implemented in a group by the instructor (Gunderson and Moore, 2008). These management techniques include clear task instructions in which students are emphasized to help one another (Cohen, 1994). Other methods for enhanced cooperative learning include offering some reward for achieving the group's goal, assigning role and tasks to each individual in a group, holding each individual responsible for his or her own learning, and providing team-building activities (Springer et al., 1999).

Gokhale (1995) evaluated the effectiveness of collaborative learning versus individual learning in enhancing drill-and-practice skills and critical-thinking skills. There were two research questions of her study: will there be any significant difference in achievement on a test comprised of "drill and practice", and will there be any significant difference in achievement on a test comprised of "critical- thinking" items between individual students and group of students. Critical-thinking items were those that involved analysis, synthesis and evaluation of concepts and drill-and-practice items were those that pertain to factual knowledge and comprehension of the concepts. Population for this study was students enrolled in the Basic Electronics course in spring 1993 in Western Illinois University, Macomb, Illinois. Independent variables were individual learning and collaborative learning, and dependent variable was the post test score. Lecture was given to these students and then a test was conducted which included both the drill-and-practice and critical-thinking items. Test was given in two ways, one who gave the test individually and the other was in group after explanation. Groups for this test were self-selected and were of size four. A statistical analysis was conducted on the test score and the results said that students working in group performed significantly better on critical-thinking tests. For drill-and-practice test, the results were almost equal and both the groups performed well. Conclusion of this article was very clear that critical-thinking and problem-solving skills are enhanced in group learning.

In a newsletter article Speaking of Teaching (1999), it was discussed that many instructors break their classes into small groups, decided by teachers or students themselves, to accomplish some tasks lasting for may be a period, several sessions or a part of the semester. It was also reported that group learning tasks requires interdependence and no one has to do that task alone. To gear this activity properly in the class, it is important for the instructor to plan those group tasks properly. These group activities help students to gain knowledge and complete the task enthusiastically. It was suggested that group tasks should be assigned to students that promotes learning. The size and number of groups was shown to be an important factor for an efficient performance. Group performance can be increased by designing tasks in such a way that considers individuals involvement, group discussions, feedback granting and moreover giving rewards for best group performance. The second point that is being shown as important in article is to teach students to work in groups. In this point it has been made clear that how students can adopt management skills as many of them may not have idea of how to work in a group. One very simple method for this is assigning simple roles in the group like who will take note, who will outline a plan of progress, who will evaluate critics and many others. Third point in the article was about forming and guiding groups. In this point it is mentioned that groups with 4-6 team members works best however it also depends on tasks. Also, groups should be guided with time to time and for that instructor can keep certain initial reports and plans deadlines which can also be important to students to receive feedback from the instructor. Lastly, it was discussed that how these tasks should be graded by looking at individual performance in groups or just group performance.

Another important method of improving the individual performance and thus group's productivity is use of heterogeneous groups (Cohen, 1994; Blumenfeld et al., 1996). The groups are more successful when members are drawn from high and low achievement levels compared to when all students have same level of achievement. The use of heterogeneous group increases hypothesized benefits to low-achieving students of receiving instruction from high-achieving students or because of the desire to increase friendliness between members of different social groups (Cohen, 1994). Only students of middle achievement are less likely to benefit from their interaction with others of higher or lower achievement, as they are less likely to engage in the group and, rather, do better in homogeneous groups of other middle achievers (Cohen, 1994; Blumenfeld et al., 1996).

Walters (2000) reported that group work is a sink-or-swim relationship and by that the author meant to say that one cannot be successful unless his/her partners are. It was also reported that group learning might affect when not all the members of the groups are working. For these, there are many solutions given by different authors. Some of these are assigning different roles to the team members and getting evaluation from the peers. In other paper by Brindley et al. (2009), it has been mentioned that "access to learning is not meant by access to content". Students should get more chances to connect with the people and interact during the course work. The group activities should be done on the basis

of mutual understanding, help and proper communication. There are few benefits which author did mention about the collaborative learning and those are development of critical thinking skills, co-creation of knowledge and meaning, reflection and transformative learning. This paper was focused more on online learning activities, however, the benefits which was reflected by the author are applied to group learning whether it be online or in class. Group learning has more benefits like it includes diversity, different styles and their cultures. Today education is made suitable as per the global environment and therefore students should adapt diversity easily, and group learning can be the best ways to achieve it.

Gunderson and Moore (2008) described three types of group selection methods: self-selection, random selection and criteria-based selection. In general, groups can be formed using individual-selection (or self-selection), random-selection, and criterion-based-selection (or performance-based-selection). In individual-selection, students choose their group members by their own choice (e.g., based on knowing each other, based on previous experience of working together, based on nearest sitting in the class). The random-selection is conducted by the instructor (e.g., based on alphabetical order of students' names, group assignment lottery drawn in the class). The criterion-based-selection is administered by instructor and includes some sort of students' assessment or data (e.g., based on performance in an exam, based on background summary of students) for assigning students in groups (Rau and Heyl, 1990).

The aim of this study was to test two most common types of group selection methods- self-selection and random selection, and to observe the differences in group functioning and the academic achievement of the group based on their selection method. There were two phases of this research, sample for both the phases were the junior-level students from Advanced Construction Systems. First phase was quasi-experimental mixed method, a type of research approach for conducting studies for real-life situations where there is an active independent variable that the researcher may be able to manipulate, but randomly assign subjects to comparison and experimental groups and mixed method is that in which both quantitative and qualitative approaches are used. First approach was to determine which group selection method is better self-selection or random assignment. In second phase two selection methods, self-selection and purposefully selected, were compared and determined which one is better. Second phase was completed by utilization of qualitative method. The results of the study mentioned that the conclusion of self-selected groups was unclear as most of the students did not know about their teammates earlier which actually turned out as a randomly-selected group, so quasi-experimental design failed to produce the expected result. Results of second phase were significant, however both the methods failed to determine the best group selection method. Although an intermediate deliverable improved the performance of the students. It was concluded that students learn in each group regardless of the technique groups are made. Ultimately, results provided no difference between any methods of selection, it was dependent on students and their choices who liked to work in what way. It was more significant at the end to know that group work improved student learning compared to individual learning.

3. Methodology

3.1 Subjects and Research Design

The population of this study comprised of undergraduate students enrolled in two different lab-based construction management courses, namely, Course#1 and Course#2. The courses allow students to gain knowledge about the fundamentals of different construction materials, strength of materials, and standardized testing procedure to determine the mechanical and physical properties of materials. The courses were designed in a way that along with the lectures they also had lab hours to help students gain practical knowledge by performing laboratory activities. The courses were offered in spring 2012, fall 2012 and spring 2013. Based on the enrollments, each section had around 18 to 23 students and as per the class size, students were divided in groups of 4 or 5.

The reason for choosing this group size was based on the results of study conducted by Rau and Heyl (1990). The study suggested that in case of smaller group sizes like size of 3, the collective decision making process lacks divergent thinking styles and also the diversity involved is less. Moreover, small group sizes lack divergent thinking styles. On the other hand, if larger groups with size of 6 are considered, then it gets difficult to figure out whether each member team has contributed equally or not. In larger group sizes there are chances that any of the team member may take a free ride without participating actively towards the work.

The lab based construction management course had a class meeting time of 1 hour 50 minutes for each class. Every class meeting consisted of a 50 minute lecture followed by 1 hour for lab work. The lab project work comprised of various assignments such as preparation of sample, testing of sample, and analysis of lab data by the whole group. Moreover, each student was supposed to prepare and submit individual formal laboratory report.

The frequency of class meetings for lab based construction management course was twice a week. The class itself consisted of setup for both lecture and laboratory. A total of six projects were completed by students throughout the semester in both courses. During the entire semester, students followed the same approach of attending lectures and

working in labs to complete the given projects. Also, the same approach was followed by the instructor in fall and spring semesters.

In spring 2012 semester, students were grouped in two courses by using random-selection method by instructor. All students were grouped in the alphabetical order using their last name. In fall semester 2012, instructor grouped students as per performance-based-selection method. For the performance-based selection method, in the beginning one lab project was completed individually by all students without forming any group. Then based on individual performance in the first lab project students were grouped to maintain balance. The balance in each group was achieved by teaming students such that two members of each group had high performance and other two had low performance. In fall semester 2013, instructor used individual-selection method for making groups. All individual students were given time for discussion in the second class to decide and come up with their own group members.

3.2 Data Collection and Measures

Overall, the data points were collected from approximately 128 subjects. The learning of each group was evaluated by calculating an average of scores received by all fellow members in the corresponding lab projects. The lab projects comprised of only 20% of overall grade of an individual student. Therefore, average students' score (out of 100) was also evaluated for each course. Additionally, to examine the differences in the perceptions of construction management students worked in groups formed by using different group selection methods, a questionnaire was designed. Each student was required to complete the questionnaire in private at the end of semester and turn it in to the instructor. It was used to assess students' perceptions on the groups and experience with the fellow group members. The questionnaire comprised of 14 questions, all the questions were cautiously framed. Following questions were part of the questionnaire:

(1) Question#1: The way in which the group members were selected affected my experience of working with the group.

(2) Question#2: The working in a group encouraged me to take responsibility in my learning.

(3) Question#3: The working in a group helped me to improve participation and learning.

(4) Question#4: The group work encouraged me to develop understanding of construction materials.

(5) Question#5: Even if I have trouble learning the material of group lab project, I tried to do the work on my own, without help from my fellow group members.

(6) Question#6: When I became confused about something regarding the lab project, I contacted/called my fellow group member.

(7) Question#7: I tried to change the way I study in order to fit the group lab project requirements.

(8) Question#8: When group lab work was difficult, I either gave up or only worked on the easy parts.

(9) Question#9: I tried to relate material covered in lecture(s) to group lab project assignment(s).

(10) Question#10: Our group had regular meetings.

(11) Question#11: I attended group meetings regularly.

(12) Question#12: I fairly contributed in the sample preparation part of the lab project?

(13) Question#13: I fairly contributed in the sample testing part of the lab project.

(14) Question#14: I fairly contributed in the report writing part of the lab project.

As noted above, most of the questions were focused majorly on the effects which group work had on the students learning experience. Each question was rated on the scale of 1 to 5, 1 representing strong disagreement, 3 representing the neutral or not sure response and 5 representing the strong agreement. All the students of all the sections were asked to complete the survey at the end of the class. The responses of students on the survey had no impact on student's grade. All the responses were kept confidential. The collected data was analyzed to compare level of productivity and perceptions of students among different groups. The questions were focused on the learning strategies of the students for group lab projects. However same projects were assigned in both courses. All the 14 questions of survey emphasized on impact the group work had on the student's performance and his/her overall learning throughout the project. As it is supposed to be the case that doing a project in group leads to contribution from diverse thinking, the questionnaire asked students about their experience working with the group. The purpose of survey questionnaire was to know whether the students actually were able to take advantages of group work and also whether each team member contributed to the project in best possible way or not.

5. Findings and Discussion

A summary of scores of different groups for Course#1 are presented in Table 1. As evident from Table 1, for Course#1,

random-selection showed least average score (86.5) with highest standard deviation (7.7) of groups. Both performance-based- and individual-selection resulted in similar average score of groups. Further, overall score of students was calculated by using 20% weightage to laboratory projects and remaining 80% weightage to exams and assignments, as presented in Table 1. It is interesting to note that overall score of students in random-selection class showed highest average score of 91.2 followed by performance-based (90.9) and individual-selection classes (89.5). This is an indication that students in the class having randomly-selected groups were academically superior followed by performance-based and individual-selected groups. Similarly, a summary of scores of different groups for Course#2 are presented in Table 2. It is evident from Table 2 that individual-selected groups proved productive with highest average score of 93.4 followed by randomly-selected and performance-based-selected groups. Additionally, one of the groups in individual-selection received highest score of 97.6. However, overall scores in Course#2 indicate that students in random-selection were academically better as compared to students enrolled in class having groups formed by individual-selection method.

Table 1. Course#1 Project Scores for Randomly-, Performance-Based- and Individual-Selected Groups

General information and scores	Method of Group Selection		
	Random	Performance-based	Individual
Number of students	23	23	22
Number of groups	5	5	4
Number of projects	6	6	6
Average group project score (out of 100)	86.5	89.7	89.6
Highest group score (out of 100)	92.9	95.5	95.4
Lowest group score (out of 100)	72.9	83.2	84.6
Sandard deviation of group project score	7.7	5.2	4.5
Standard deviation of students' overall score in the projects	13.5	5.8	6.3
Average overall students' score in the class (out of 100)	91.2	90.9	89.5
Standard deviation of students' overall score in the class	6.7	4.8	7.7

Table 2. Course#2 Project Scores for Randomly-, Performance-Based- and Individual-Selected Groups

General information and scores	Method of Group Selection		
	Random	Performance-based	Individual
Number of students	21	21	18
Number of groups	5	5	5
Number of projects	6	6	6
Average group project score (out of 100)	92.2	89.1	93.4
Highest group score (out of 100)	95.4	95.5	97.6
Lowest group score (out of 100)	86.6	82.6	86.9
Sandard deviation of group project score	3.4	4.6	4.6
Standard deviation of students' overall score in the projects	3.4	7.0	6.2
Average overall students' score in the class (out of 100)	91.7	88.0	88.6
Standard deviation of students' overall score in the class	3.8	6.2	7.4

The responses of 128 subjects in questionnaire are presented in Table 3. Based on responses presented in Table 3, it is evident that subjects were least satisfied with randomly-selected groups and most satisfied with individual-selected groups. For example, approximately 30%, 25% and 24% responses were of grading 4 or 5 (Moderately or Strongly Agree) in randomly-, performance-based-, and individual-selected groups, respectively. The responses to Questions#2, #3 and #9 indicated that all subjects agreed that group work encouraged/helped them in learning and relating lectures to group lab projects. The response to Question#8 (When group lab work was difficult, I either gave up or only worked on the easy parts) indicated no subject gave up when any difficulty was encountered during the lab work. Overall, students were positive towards group lab activities.

Table 3. A Summary of Students's Responses to Questionnaire

Question#*	Random-selection		Performance-based-selection		Individual-selection	
	# of subjects with grading of 1 or 2	# of subjects with grading of 4 or 5	# of subjects with grading of 1 or 2	# of subjects with grading of 4 or 5	# of subjects with grading of 1 or 2	# of subjects with grading of 4 or 5
1	7	19	9	18	11	20
2	0	36	0	36	0	38
3	0	36	0	36	0	38
4	2	31	2	32	1	32
5	8	16	7	18	6	24
6	7	31	6	28	3	33
7	8	15	7	16	8	19
8	37	0	35	1	38	0
9	0	31	0	31	0	31
10	15	14	14	17	11	15
11	9	18	9	20	5	25
12	3	32	2	34	2	35
13	3	31	2	34	2	35
14	3	33	2	32	3	36
Total	102	343	86	353	90	381

*Specific question is provided in the section entitled *Data Collection and Analysis*

6. Concluding Remarks

This study was undertaken to evaluate influence of group selection method on the learning of groups. A total of three group selection methods, namely, individual-selection by student, random-selection by instructor, and performance-based-selection by instructor, were utilized. The population of this study comprised of 128 undergraduate students enrolled in two different lab-based construction management courses, namely, Course#1 and Course#2. The learning of each group was evaluated by calculating an average of scores received by all fellow members in the corresponding lab projects. At the end of the semester, students were also asked to complete a questionnaire consisting of 14 questions. Data from all the questionnaires were collected and analyzed.

All groups formed by using individual-selection method showed higher productivity. The students individual-selected groups showed more interest towards lab projects even though students in the performance-based- and randomly-selected groups were academically superior. The responses of individual students in questionnaire indicated that they were least satisfied with randomly-selected groups and most satisfied with individual-selected groups. All groups found it interesting and positive to work in groups regardless of group selection method.

Acknowledgements

Financial support for this study was provided through University Research Grant, College of Applied Science and Technology at Illinois State University.

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