

# Key Factors in Construction Engineering and Management Education to Facilitate Student Engagement and Collaborative Learning

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This paper addresses the survey outputs of 11 class activities for a construction management static course. Students were asked to evaluate the class activities in terms of their learning experience and class environment. The 11 class activities are the break-the-ice game, individual meeting with an instructor, boot camp, special office hours, office test review, term project, in-class tutor, team quiz, study group sessions, term project, and team member evaluation. A descriptive statistics and exploratory factor analysis revealed that any class activities related to students' grade were highly ranked for students learning and any class activities related to building relationship among class participants were highly ranked for the class environments. Using exploratory factor analysis, 11 class activities were clustered by three latent groups as relationship with the instructor, relationship with peer students, and team oriented for both students learning and class environment. This output indicates that any relationship with the instructor and peer students in the class plays a key role in students learning and class environment. A team-oriented class is also a key factor of students learning and class environment. This result will be beneficial for practitioners when they design class activities to improve students learning and class environment.

**Key Words:** Class Activities, Class Environment, Team Work, Relationship

## Introduction

A classroom is a basic unit of college life for students. The classroom is a place where students learn their new materials in the field of study and also develop a social relationship with peer students and instructors. Students spend most their time in the classroom interacting with peer students and an instructor. Since a classroom environment is based on a dynamic social system with interactions among students and the instructor (Trickett and Moos 1973), the class environment has a huge influence on students' learning and the relationship among peers and the instructor (Velayutham and Aldrge 2013). Kim and Lee (2018) address the influence of class environment on students' learning improvement and positive perception about the class itself. The class environment consists of many factors like class participation (Landau and Meirovich 2011), respect among class participants (Miller and Pedro 2006), and psychological safety or no emotional harm (Holley and Varble 2006), and support from all class participants (Cole et al. 1999). Waldeck (2006) addresses that students become more proactive and positive towards the classes if they seem like to have more personal relationship with the instructor. In addition to these factors for the class environment, class activities play an important role with the class environment and students learning in the class. Kim and Lee (2016) stress out the importance of class activities for students' learning and their perceptions to the class. Any group activities have positive impact on students' motivation and class participation (Cole et al. 1999) as well. Having students experienced group activities is a vital factor for students' success in the future because the construction industry is based on team or team work. A good relationship with team members is one (1) of main project success factors.

The purpose of this study is to address the quantitative analysis of 11 class activities in terms of influence on students' learning and class environment. The objectives are to: 1) Identify the most influential class activities on learning; 2) Identify the most influential class activities on class environment; and 3) Define key underline factors

among class activities in terms of students' learning and class environment. The literature review describes the past and current research on class environment and activities to justify this paper. The methodologies used in this paper are descriptive statistics and exploratory factor analysis. Finally, the findings are presented in the conclusions.

## Literature Review

As addressed earlier, the class environment and class activities are related to each other. Both are required for participation of students and an instructor. Each type of school, department, and program has three (3) factors affecting social climate directly or indirectly (Moors 1980). Three main factors in class environment are students' interpersonal relationships with peers and their instructors, goal-orientation of students' engagement in learning activities, and the general structure and the order of the classroom designed by the instructor (Trickett and Moos 1973). A relationship between a teacher and students and classroom activities are two (2) important factors of a creative class environment (Cole et al. 1999). Instructor's effort to pay attention to students personally has a huge influence on students' perception of the classroom environment (Trickett and Moos 1973). Students become more open to communication with their instructors in a supportive classroom environment (Myers and Claus 2012). Kim and Lee (2018) address that the classroom environment positively relates to personalized education designed by the instructor. Reaching out and more personalized education to students are necessary for instructors to improve class environment and relationship with students. It will be beneficial for both students and instructors to understand each other. "Respect is a fundamental human value that forms the basis of character and personality. It can be considered a principle or standard and an appropriate way of acting" (p.293) (Miller and Pedro 2006). Respecting all class participant is crucial and a main factor to create a good class environment for learning and social (Miller and Pedro 2006). A safe classroom is a place where students could express their individuality without any emotional or psychological harm (Holley and Steiners 2005). A safe classroom concept is very important for the class environment. This classroom helps students freely ask any questions and be themselves to all class participants. The supportive climate requires support from both students and instructors and it is necessary for student to perceive the existence of a supportive climate in the class (Landau and Meirovich 2011). It depicts that all class participants have to be supportive to each other for a better class environment. Many factors addressed before have positive relationships with classroom environment and students' learning after all. Although it is evident that all class participants – students and instructors are responsible for the class environment, from many students' perspective, instructors are solely in charge of the classroom environment (Holley and Steiner 2006). Therefore it is very important for instructors to stress out that both instructors and students are responsible for the classroom environment to students as often as possible.

Students' learning, achieving academic goals, and their relationship with peer students and instructors are positively related to classroom environments. From this perspective, students' motivation are really critical to satisfy students' demands. Students' perceptions and preference of the classroom and students' goal orientation and preference are positively related to each other (Tapola and Niemivirta 2008). "Teachers' practices and classroom norms, rules, and routines contribute to students' perceptions of goal structures" (p.368) (Patrick et al. 2011). The perceived classroom environment and graded performance and intrinsic motivation influence each other (Church et al. 2001). The classroom environment and the students' perceptions of engaging in academic tasks and the classroom goal structure are related to each other (Ames 1992). Students' supportive relationships with their peers and teachers' support are statistically significant on both students' learning goal orientation and task value (Velayutham and Aldrdge 2013). Students want instructors to have some interest in them academically and personally and like to interact more with instructors (Cole et al. 1999). Students intentions for communicating with instructors are linked to students' learning outcomes (Myers and Claus 2012). Any programs or classes based on relationships among participants could have more positive results and a proposed class should be task-oriented and supportive (Moors 1980). To provide a good classroom environment and personalized education, being in a good relationship with students is very important for instructors (Kim and Lee 2018). Even though both students and instructors have huge impacts on the classroom environment, the impact from instructors is larger than those from students (Moors 1980).

The classroom is a small society in the college but its impact on students' learning and social life is huge. As many researchers address before, the classroom environment is positively related to students' learning outcomes, relationships between students and instructors and peers. It is a must to build a good relationship among class participants to have safe, dynamic, supportive classroom environment with respect to type of class and materials.

Based on the discussion before, defining key underline factors for students' learning and classroom environment will be addressed.

## **Class Activities**

The class described in this paper is a statics class for mainly sophomore and has three (3) lecture hours in total with two (2) meetings per week. There were approximately 25 students in the class. Most of class activities were based on teams and each team consisted of three (3) or four (4) members. In the course, class activities play a very important role to encourage students to be positive in the class and contents, and finally achieve their academic goals. Students and the instructor tried to spend some extra hours outside of class to build a relationship between the instructor and students. This was a way of how the instructor and students built a personal relationship with each other and it led students change their perceptions in the instructor and class. There were two (2) types of activities as "Individual" and "Team." "Individual" represents any activity done by a student and "Team" represents any activity done by a team. There were seven (7) in-class activities and four (4) off-class activities. The detailed description of each class activity is followed.

### *In Class Activities*

#### *Class Socials*

There were two (2) class social activities. The first one is called 'Break the Ice Game' and the second one is 'Boot Camp.' The break the ice game is done on the first day of semester to help students get to know each other and the boot camp is done in the middle of semester for mainly as a team building activity. The first game is done by a randomly formed team on the first day. It is a great opportunity for students to get an idea of their classmates and from the instructor perspective, it is a good opportunity to learn students in the class. The boot camp is a quiz show and teams solve the quiz problems as a team. The problems are not related to the class but current culture.

#### *Test, Test Review, & Team Quiz*

Students had two (2) team quizzes, two (2) midterms, and one (1) final. Students could do the test review in the instructor's office. The instructor gives any students who do the test review in the office two (2) test review bonus points. It is a way to encourage students to do their test reviews. Students have an opportunity to earn some bonus points in Test 2. The instructor informs that students could earn five (5) bonus points if their team average is equal or higher than that of class. It keeps students motivated to study together with their team members as group reward contingencies (Michaels 1977). Through this process, students have more time with their team members and leads to building a good relationship with their peers. There were two (2) team quizzes between two (2) midterms. All team members solve the problems as a team. If there are some conflicts with answers, the teams have to resolve the issues to come up with one (1) final answer. During this process, regardless of being right or wrong, everybody could learn the materials.

#### *Term Project*

The term project was performed on the last day of the semester. Each team had to build a straw structure that could hold as many books as it could. Each team had about one (1) month to design their structure. The instructor provided each team with a sample set of materials that students needed for their term project. The materials students used for the term project were 16 straws, eight (8) paper clips, and a foot-long magic tape. Each team had to build their structure within 20 minutes. The teams could bring any tools for their structure except for bond, glue, or heated tools.

#### *Team Member Evaluation*

At the end of semester, each team member had to evaluate their team members. It was necessary for them to do because many of activities done in the class were based on the team like the construction industry. Students could put themselves in somebody else's shoes. It is a good tool to keep every team member participated in positively.

Many of students will become a position that they have to evaluate somebody in the future. It is a great exercise for them to evaluate peer students.

### *Off Class Activities*

#### *Individual Meeting*

The instructor required all students to have a meeting in the beginning of the semester. The individual meeting was designed to build an individual relationship with students. Each student signed up for a meeting at least a day prior to the meeting and the meeting ran for about 30 to 40 minutes. The goals of meeting were to 1) Let students know that instructor was willing to help them and 2) Describe what instructor's expectation from students in the class. At these meeting, students were more closed to the instructor and shared some of their personal stories with the instructor.

#### *Extra Office Hours and Study Group*

In addition to the regular class hours, the instructor offered one (1) or two (2) sessions of study group per week. It was offered twice a week at 07:00 PM through 09:00 PM. This was for those who needed more help than the others or for those who did not want to ask any questions during the class. Many students used this session for their assignments. In the beginning, the instructor helped most of students but as time went by, students helped each other. The instructor offered extra office hours a night before a test in the library. If any students had last minute questions before the test, they could stop by the library and ask me any questions. In general, one third of students in the class showed up in the library to study.

#### *In-Classmate Tutoring*

Due to the nature of statics, some of student had hard time with the course during the semester. The instructor sought for voluntary in-class tutors to help those students. There were three (3) or four (4) in-class tutors and the instructor matched tutors up with tutees. This is an improvement of peer relationship based on students' needs as well. Tutors knew the best way to learn is to teach or help somebody.

## **Design of the Study**

To define key underline factors of students' learning and class environment based on class activities, students' surveys were collected from six (6) different semesters in a row. The survey was done on the second last day of the semester. The instructor was not there when the students participated in the survey because students were instructed to write down their names on the survey. The instructor had never gotten the surveys back until all final course letter grades were posted into the school system. By doing this, the students felt more freely and honestly to answer the survey questions. The data collected from students' surveys are evaluation of 11 class activities in terms of students' learning and class environments using Likert scale, 1 is strongly disagree and 5 is strongly agree. 11 class activities are below.

- Activity 1: The first game (game of truth – break the ice)
- Activity 2: Individual meeting with an instructor
- Activity 3: Study group (study session)
- Activity 4: Special office hours in the library a night before the test
- Activity 5: Boot camp (team building activity)
- Activity 6: In-office test review with the instructor
- Activity 7: Team quiz
- Activity 8: Team bonus points in Test 2
- Activity 10: Term project activities in class
- Activity 11: In-class tutor (peer students tutor)
- Activity 12: Team member evaluation

Activity 9 which is student guest speakers who took the course in the previous semester has to be excluded because, in the first semester, there were no guest speakers. The instructor invited some students who took the course in the previous semester to a new class and provided some time with all students combining new and old students. Since the instructor left the classroom, the students could have their own time about the course. All data sets were from the same class and the instructor taught the same course for six (6) semesters in a row. There are 117 students participated in the survey in total. A descriptive statistics and exploratory factor analysis were used to define the key underline factors of students' learning and class environment based on the class activities.

## Data Analysis and Results

### *Descriptive Statistics*

A descriptive statistics was computed using Microsoft Excel. The means and standard deviation of 11 activities are shown in Table 1 in terms of students' learning and class environment. With respect to students' learning, Activity 2, 4, and 6 are ranked within top 3. Activity 2 is an individual meeting with the instructor, Activity 4 is special office hours in the library a night before the test, and Activity 6 is in-office test review with the instructor. Activity 4 is ranked highly, Activity 6 is the second ranking, and Activity 2 is the third ranking. From this result, students still think the instructor is the key factor of their learning or at least any activities related to the instructors. Activity 2 shows that students want to have a meeting with the instructor to build an individual relationship. In terms of class environment, the three (3) top activities are Activity 1, 4, and 5. Activity 1 is the first game (game of truth – break the ice), Activity 4 is the special office hours in the library a night before the test, and Activity 5 is boot camp. Activity 5 is ranked highly, Activity 4 is ranked as the second, and Activity 1 is ranked as the third. Boot camp is a team building activity done in the middle of the semester. Students seem like to have a boot camp after they get to know their team members and other peer students. From Activity 4, students like to study together with other peer students and the instructor in the library. In this case, students think that studying together makes a better class environment through interacting each other including the instructor.

Regarding the standard deviation of students' learning, Activity 1, 8, and 10 are the three (3) highest among 11 activities. Activity 1 is the first game (game of truth – break the ice), Activity 8 is team bonus points in test 2, and Activity 10 is term project activities. From the instructor perspective, Activity 8 is a key factor for team building and reward. Students may not see the benefits of term project activities from their learning materials. Activity 2, 6, and 8 are three (3) top highest standard deviation. Activity 2 is an individual meeting with the instructor, Activity 6 is in-office test review, and Activity 8 is team bonus points in test 2. Activity 6 has the highest standard deviation as 1.063. It means there is some gap among students to see these three (3) activities as a good indicator of class environment. Only Activity 8 has one (1) of the three (3) highest standard deviations in both of students' learning and class environment. It is evident that there are large gaps among students in terms of perceptions of these activities for their learning and class environment.

Table 1

### *Means and standard deviation of 11 class activities*

	Activity	Students' Learning		Class Environment	
		Mean	Standard Deviation	Mean	Standard Deviation
1	First Game	3.853	1.061	4.276	0.847
2	Meeting with Instructor	4.310	0.895	4.147	0.976
3	Study Group	4.276	0.867	4.259	0.842
4	Special Office Hours	4.543	0.770	4.422	0.811
5	Boot Camp	4.147	0.922	4.431	0.822
6	In-office Test Review	4.336	0.870	4.009	1.063
7	Team Quiz	4.224	0.882	4.310	0.932

8	Team Bonus Points	4.293	0.983	4.233	0.986
10	Term Project	3.922	1.068	4.086	0.979
11	In-class Tutor	4.138	0.880	4.164	0.880
12	Team Member Evaluation	4.267	0.781	4.095	0.947

Correlations among 11 activities are performed using SPSS in terms of students' learning and class environment. Table 2 shows the correlations among activities in class environment. Only two (2) sets of activities have mild correlations. Activity 2 and 6 have 0.714 and Activity 3 and 4 have 0.724. Both have a p-value of being less than 0.00 at alpha 5%. The results of correlations among 11 class activities in students' learning are not shown here because there are no significant correlations among activities. All correlation values are less than 0.61. From this perspective, most of 11 class activities in terms of students' learning and class environment are not correlated to each other.

Table 2

*Correlations among 11 class activities in class environment*

	1	2	3	4	5	6	7	8	10	11	12
1 First Game	1.00	.222	.214	.219	.498	.141	.219	.130	.325	.124	.258
2 Meeting with Instructor		1.00	.447	.499	.147	.714	.234	.287	.257	.353	.330
3 Study Group			1.00	.724	.063	.508	.106	.301	.025	.617	.218
4 Special Office Hours				1.00	.063	.556	.123	.308	.074	.434	.161
5 Boot Camp					1.00	.045	.219	.078	.350	.069	.269
6 In-office Test Review						1.00	.311	.410	.190	.505	.325
7 Team Quiz							1.00	.644	.264	.169	.201
8 Team Bonus Points								1.00	.158	.393	.346
10 Term Project									1.00	.224	.335
11 In-class Tutor										1.00	.395
12 Team Member Evaluation											1.00

*Exploratory Factor Analysis*

In the previous section, 11 class activities were addressed in terms of students' learning and class environment. There are some activities preferred by students and some activities not preferred by students. Each activity has its own purpose to exist. One (1) of objectives of this paper is to define key underline factors of students learning and class environment based on class activities. To meet this objective, exploratory factor analysis was used. In sociology and psychology, it is sometimes impossible to measure the variables effects directly so factor analysis is commonly used in these disciplines to measure the effect indirectly. Factor analysis is a statistical technique for uncovering factors by observed variable. The main purpose of factor analysis is to define the relationship among observed variables by factors (Brown 2006). The factors are called 'Latent Variable.' Exploratory factor analysis is used to reduce the number of data into smaller number of data set by factors. From this perspective, 11 class activities would be grouped by latent variables.

The factor analysis was performed using SPSS. The method for exploratory factor analysis is Principal Component Analysis and Varimax Rotated with Kaiser Normalization. The results of exploratory factor analysis are shown in this section. According to Thompson (2004) and Brown (2006), how many numbers of factors are extracted relies on how many eigenvalues are greater than 1.0. The results of exploratory factor analysis are shown in Table 3. The three (3) factors are extracted from 11 original class activities. The eigenvalue of the fourth factor is not greater than 1.0 which is not shown in Table 3. The factor loadings are shown in Table 3. Factor loadings represent regression slopes between latent variables and indicators (Brown 2006). Indicators are students' learning and class environment in the factor analysis. According to Brown (2006), there is no specific way to choose factor loadings but 0.4 or greater of factor loading is reasonable. In Table 3, any factor loadings less than 0.4 are hidden.

Table 3

*Factor Loadings (Rotated Matrix)*

	Activity	Students' Learning			Class Environment		
		Factor 1	Factor 2	Factor 3	Factor 1	Factor 2	Factor 3
1	First Game		0.852			0.771	
2	Meeting with Instructor	0.520			0.688		
3	Study Group	0.831			0.869		
4	Special Office Hours	0.775			0.841		
5	Boot Camp		0.823			0.821	
6	In-office Test Review	0.624			0.759		
7	Team Quiz			0.837			0.859
8	Team Bonus Points			0.802			0.841
10	Term Project		0.540			0.658	
11	In-class Tutor	0.662			0.694		
12	Team Member Evaluation		0.507			0.452	

Both of students' learning and class environment have the same patterns in terms of extracted factors. Factor 1 contains Activity 2, 3, 4, 6, and 11, Factor 2 contains Activity 1, 5, 10, and 12, and Factor 3 contains Activity 7 and 8. There is no specific way to name each factor. Many activities of Factor 1 are related to the relationship with the instructor. Many activities of Factor 2 are related to the relationship with the peer students. All activities of Factor 3 are directly related to team-team oriented. All extracted factors as Factor 1, 2, and 3 are called 'the relationship with the instructor,' 'the relationship with peer students,' and 'team-oriented' respectively. From these results, three (3) factors are found from 11 class activities. It shows that three (3) factors (the relationship with the instructor, the relationship with the peer students, and team oriented) are key underline factors for students' learning and class environment.

## Conclusions

This paper addresses the survey outputs of 11 class activities for a construction management statics course. Students were asked to evaluate 11 class activities based on class activities' impact on students' learning and class environment. The three (3) top activities of students' learning are Activity 2 (an individual meeting with an instructor), Activity 4 (special office hours in the library at a night before the test), and Activity 6 (in-office test review with an instructor). It is evident that students have some values on interactions with the instructor in terms of their learning. Activity 1 (first game – break the ice), Activity 4 (special office hours in the library at a night before the test), Activity 5 (boot camp) are chosen as top 3 activities in terms of class environment. Regarding the class environment, students prefer any activities related to the peer students. Activity 4 is the only one (1) activity for both categories. It means Activity 4 itself fulfills the students' demands on learning and class environment. These results show that it is necessary to have some class activities that students interact with each other for learning class materials and class socials at the same time. Exploratory factor analysis is used to define key underline factors for both students' learning and class environment based on the class activities. There are three (3) factors extracted from 11 class activities in both categories. Factor 1 consists of Activity 2 (individual meeting with an instructor), Activity 3 (study group), Activity 4 (special office hours in the library at a night before the test), Activity 6 (in-office test review with an instructor), and Activity 11 (in-class tutor). Factor 2 consists of Activity 1 (first game – break the ice), Activity 5 (boot camp), Activity 10 (term project activities in class), and Activity 12 (team member evaluation). Activity 7 (team quiz) and Activity 8 (team bonus points in test 2) are found in Factor 3. Factor 1 is named as the relationship with the instructor, Factor 2 is named as the relationship with the peer students, and Factor 3 is named as team-oriented. Even though this paper starts with 11 class activities, there are three (3) key underline factors found for both students' learning and class environment. Based on the results, any relationships among class participants are crucial for the students' learning and class environment. Students prefer activities with peer students for their learning and class environment. The outcome of this paper is beneficial for practitioners to plan and design class activities improving students' learning and providing a better class environment.

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