Correlation between Classroom Engagement and Academic Performance of Engineering Students

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Abstract

Enrollment, retention and graduation rates of students have been a challenge that requires immediate attention from stakeholders of higher education institutions. Though many students enter into engineering fields, retaining these students has been challenging for institutions across the country. If student engagement in the classroom can be improved, it may lead to higher academic performance and higher graduation rates in engineering disciplines. Student engagement in the classroom plays an important role in the overall learning process, as more engaged students appear to have better academic performance. Engagement may depend on certain intellectual, emotional, behavioral, physical, and social factors. Student engagement has been identified as an important factor because it empowers students with the ability to acquire and retain information during lectures and other classroom activities. Student engagement can be measured using different methods; such as self-reporting, observations, and recording facial expressions and gestures in the classroom. The first pilot study measures student engagement using classroom observation of the instructor and student gestures and activities, as well as student's self-reporting. The engagement data collected from classroom observation and student self-reporting was compared with students' academic performance to determine any correlation between academic performance and classroom engagement. Statistical analysis of the data showed weak correlation between classroom engagement and academic performance among students, those with reportedly more classroom engagement did not show better academic performance, and vise-versa. Due to limitations of this pilot study, the findings may not be conclusive and require further study. By understanding the relationship between engagement and academic performance, an intervention plan can be developed to improve the academic performance of students who have lower levels of engagement.

Keywords: engagement, academic performance, student success, STEM, engineering education

1. Introduction

Engagement has been used to describe diverse behaviors, thoughts, perceptions, feelings, and attitudes (Reschly & Christenson, 2012). Engagement is defined as a growth-producing activity where a person pays deep attention and focus in responding to his/her environment (Hart, Shelley, Kaitlin, & Jimerson, 2011). The classroom engagement of students can be measured by observing behaviors, attitudes and activities that contributes to meaningful learning of the materials. The student's attitudes and feelings were measured using a self-reporting questionnaire about their level of engagements. The current study uses classroom observation of student behavior and activities by measuring their gestures and facial expressions.

As our society's technology advances rapidly and economy booms, the demand for Science, Technology, Engineering and Mathematics (STEM) graduates has increased (Chen & Soldner, 2013). The graduation rate of students from STEM degrees in the United States lacks behind the growing market demands creating a shortage of skilled employees in the STEM fields (Anderson, 2017). While a large number of students enter into STEM fields, many students become dissuaded, and change majors or drop out of university. This high drop-out rate is associated

with the participating students' low program GPAs, potentially because of low student engagement within the classroom (Fredricks, Blumenfeld, & Paris, 2004). A recent study from the US Department of Education reported that about half of the students in STEM fields leave the field before degree completion (Chen & Soldner, 2013). The national attrition rates in STEM fields were recently reported to be as high as 48% of bachelor's degree candidates and 69% of the associate degree candidates (Chen & Soldner, 2013). If student engagement within a classroom can be improved, then higher academic performance and student success may ensue, leading to higher retention and graduation rates to fill our society's growing needs.

Student engagement has been found to be a key to addressing problems of low achievement, and overcoming high levels of distraction, alienation and high dropout rates (Fredricks, Blumenfeld, & Paris, 2004). Engaged students do more than attend or perform academically; they also put forth effort, persist, self-regulate their behavior toward goals, challenge themselves to exceed, and enjoy challenges and learning (Christenson et al., 2012). Engagement is a complex construct dealing with many aspects of the educational experience such as attending lectures, participating in classroom activities, having a sense of belonging amongst peers. All aspects are a part of student engagement and are necessary for overall academic success on varying levels.

The current study measured students' engagement in the classroom using three different methods: observations, gestures, and student self-reporting. While there are other methods of measuring engagement, such as facial expression that will be conducted in the next phase of this project, the current study focused on the three methods described earlier.

2. Background

Several studies were conducted using various methods of measuring student engagement in different academic environments-- from university-level to K-12 levels (Anderson, 2017; Fredricks et al., 2011). There are arguably three different forms of engagement: affective, behavioral, and cognitive (Fredricks, Blumenfeld, & Paris, 2004). "Affective" refers to students feeling towards various aspects of their studies and academic institution. "Behavioral" is observable actions done by the student while they are at school. "Cognitive" focuses on the student's perceptions of their academic institution (Hart et.al., 2011). The current study focused primarily on the students' behavioral engagement.

A "gesture" is defined as "a movement usually of the body or limbs that expresses or emphasizes an idea, sentiment, or attitude" (Merriam Webster 2019, page 525). Gestures are widely used as a natural form of communication between persons for simple actions such as pointing to objects to expressing feelings (Rautaray & Agrawal, 2012). Within the teacher-student learning process, instructors use hand and body gestures to convey topics, as well as use movement to keep students engaged during the lecture. Students also use their bodies to convey ideas to the instructor, as students raise and lower their hands to ask and answer questions or make statements during the lecture. Some previous studies reported that people's most commonly used gestures include hand and arm movement, adjustments to seating or posture, touching of one-self i.e. stroking hair, done primarily for self-soothing, and other typical nervous ticks or repetitive, involuntary movements (Rautaray & Agrawal, 2012; Sariyanidi, Gunes, & Cavallaro, 2014). In the current study, the observers focused on and recorded movements of the arm and hand to measure students' classroom engagement. Besides being the most straightforward way to visibly measure student's engagement, at least in the form of gestures, the observers' visibility of the students is naturally blocked as each student remains seated during classroom activities. Data related to gestures were collected using the bimodal face and body gesture database (FABO) (Gunes & Piccardi, Observer annotation of affective display and evaluation of expressivity: face vs. face-and-body, 2006) attached as Appendix I.

Observational measures at the individual level to assess student's behavior has been used as an indicator of academic engagement in many studies. (Greenwood, Horton, & Utley, 2002; O'Malley, et al., 2003; Volpe, Diperna, Hintze, & Shapiro, 2005). Classroom observations are a common tool for measuring student learning and engagement (Fredricks et al., 2011). To measure students' engagement, the study used a survey called STROBE (O'Malley et al., 2003), a pre-tested classroom observation tool that provides quantitative and qualitative data for analysis from observations. This is different from gestures, as the observers will not be looking for body movements done by students and instructors, but for activities done during this time-- listening, talking, reading, organizing, writing, etc. There is also an 'other' category provided, where the observers record actions done by the student that was not given as a categorical option. Appendix II provides the STROBE survey used by observers.

One of the traditional measures of student engagement that has been widely used is self-report questionnaires (Fredricks & McColskey, 2012; Greene & Barbara, 2015; Henrie et al., 2015) which are easily administered in classroom or online. On the days that data was collected, student self-reporting data was collected using a

questionnaire handed out to each student following the lecture's completion. A copy of the sample questionnaire is included in Appendix III. The questionnaire focused on a student's reflections on his/her behaviors and activities during the class period.

3. Research Methods

The objective of the project is to develop a comprehensive academic engagement model by integrating classroom engagement, academic performance and development of an intervention plan to improve academic performance as shown in Figure 1. Due to the scope of the project, the project was organized into different phases of research. During the first phase the project scope includes measuring students' engagement in the classroom and investigate whether any correlation exists between classroom engagement and individual students' academic performance. This paper presented the first phase of the study as part of the overall project goal.

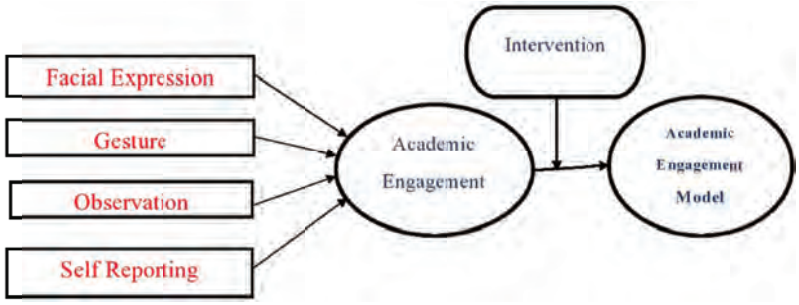

Figure 1. Academic Engagement Model Development Process

The current research focused on measuring student engagement through student self-reporting and analyzing students' classroom behavior. The classroom behavior data were collected using three different tools: observations, gesture and students' self-reporting.

The methodology used for this study consisted of:

1. Collect engagement data in three different engineering classrooms, and organize data.
2. The engagement data will be analyzed using three different modalities: student self-reporting, classroom observations, and gesture recognition.
3. Combine engagement data to create an overall level of engagement, and compare with each student's academic performance.

The following Hypotheses were investigated in the study:

A) There is no significant difference in engagement and academic performances between first-generation students and other students in the classroom

B) There is no significant difference between engagement and academic performances between male and female students in the classroom

C) There is no significant difference in the level of engagement throughout the class period

The participants included forty four students from three different mechanical engineering classess at the University of Michigan-Flint, USA. The preliminary study presented in this paper included students in courses taught by the investigator due to accessibility and availability of subjects for the study. During the next phase of the study, data will be collected from a diverse group of students from different universities. The classroom seating arrangement is shown in Figure 2 where each student was identified with a unique code in the seating chart.

4. Engagement Data Collection Process

Classroom engagement was measured using student self-reporting, observations, and gestures. Both observations and gestures data were collected by two trained faculty observers, two graduate research assistants, and the director of the Teaching and Learning Center. The classroom was divided into four quadrants, depending on the class size and number of observers with each observer assigned to a group of 8-10 students. By assigning a small number of students to each observer, the data collection process was efficient and accurate. The observers were located behind or at the side of the students seating areas to minimize distractions as students were not able to see the observers unless they divert their attention to the observer. The engagement data were collected in two different intervals; the

first set of data was collected after 15 minutes of the start of class, with the second set of data collected 45 minutes after the class's start time. The objective was to determine whether students' level of engagement changed as the class progressed with the total class time of 75 minutes. The data were analyzed using SPSS, a statistical analysis software to determine whether there is any significant difference is observed to evaluate the research questions.

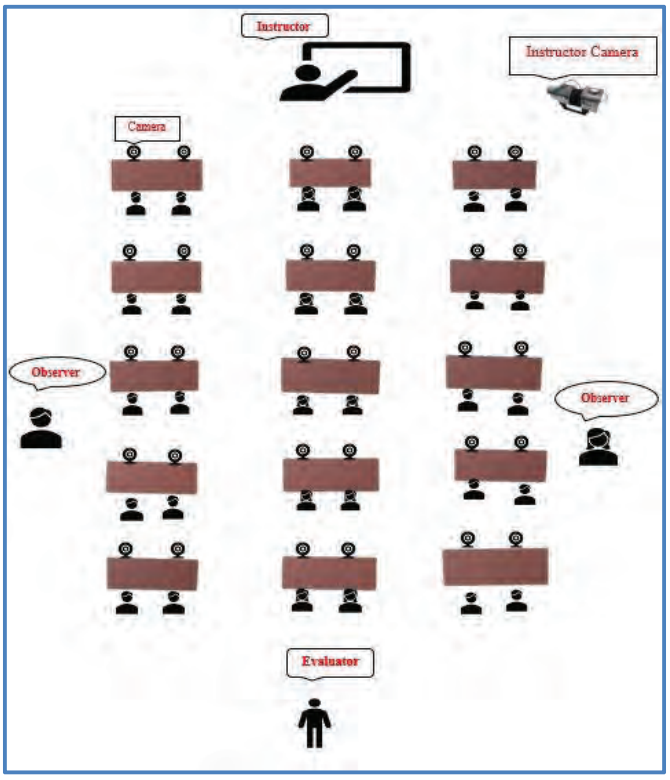

Figure 2. Seating Arrangements for Engagement Data Collection

5. Results

A one-way analysis of variance (ANOVA) was used to determine whether the mean of the dependent variable is the same in two or more unrelated, independent groups. However, it is typically used when there are three or more independent, unrelated groups. Since an independent-samples t-test is more commonly used when the data contains two groups. If there are two independent variables present, a Two-way ANOVA can be used. Alternatively, if multiple dependent variables are present, one can consider a One-way ANOVA.

The composite score was calculated based on students' responses to their self-reported survey. For each question, a score ranging from 1-5 was used, with 5 given for strongly agree, 4 for agree, 3 for neutral, 2 for disagree, and 1 for strongly disagree. The scores from each of the 9 questions were added together and divided by the total possible score, creating a ratio which is then scaled by 10. The composite score was used to determine the student's level of engagement in class.

5.1 First-gen Student

A one-way ANOVA was conducted to compare the effect of being a first-generation student on their composite score. An analysis of variance showed that the effect of being the first-generation student on their composite score was not significant, $F(1, 41) = .00$, $P = .99$. The results of the analysis showed that there is a marginally significant difference between first-generation students and other students in the class [$F(1, 41) = .00$, $P = .054$]. Therefore, hypothesis A can be rejected. A one-way ANOVA was conducted to compare the effect of gender on student's composite score. The statistical analysis results showed a significant difference between male and female students in the class [$F(1, 41) = 4.59$, $P = .04$]. Therefore, hypothesis B can be rejected based on the ANOVA results. Female students appear to be more active (active learner) than male students with higher mean scores.

5.2 First Half Vs Second Half of the Class

Data was collected during first fifteen minutes and last fifteen minutes of the class period of seventy-five minutes to determine any effect on classroom engagement. ANOVA of the effect of student's behavior in the first half of class on their composite score was not significant, [F (3, 24) = 5.80, P = .06]. Comparison of students' behavior and level of engagement during the first half of class and second half of the class showed that students were more engaged during the first half of the class compared to the second half of the class. [F (3, 24) = 5.80, P = .004]. Therefore, Hypothesis C can be rejected based on the analysis. Further analysis of the engagement data revealed that student engagement in the first half of the class was mostly listening (78.6%) compared to 7.1% of the students were engaged in talking, organizing and writing.

5.3 Relationship between Engagement and Academic Performance

The academic performances were compared with students' level of engagements as measured in the classroom. A one-way ANOVA analysis was performed. The analysis of variance showed that the statistical correlation between students' academic performance and their engagement composite score was not significant, [F (4, 38) = .80, P = .53]. Therefore, classroom engagement is not a good indicator of students' academic performance. Students may be improving their academic performance with activities outside the classroom such as group study, independent study, reading, etc.

6. Discussion

Student engagement in the classroom was measured using three different methods: student self-reporting, classroom observation, and gesture. Hypotheses were tested to determine whether there were any differences in engagement between first-generation students and other students, male and female students, and level of engagement during the first half of the class to the second half of the class. The data collected from 44 mechanical engineering students from three engineering classes are used for the analysis. The statistical analysis (ANOVA) showed that there were significant differences in engagement between first-generation students with other students, male and female students, and level of engagement during the first half and the last half of the class. Therefore, all three hypotheses were rejected. There was weak correlation between classroom engagement and academic performance of students. The limitations of this study include the small sample size from one university that may not provide a full understanding of the correlation and the results may be skewed. However, the study attempted to shed some light on the topic that will help develop the research plans for the next phases of the study in developing intervention plan leading towards an academic engagement model.

7. Future Work

Based on the current work, the future work includes collection and analysis of data from a diverse group of students from different institutions, developing an Academic Engagement Model, as well as using a facial recognition system in the classroom to collect data on student engagement and behavior. A proposal has been submitted for funding to continue the study and to develop intervention plans to improve the academic performance of students. Collection of data using facial recognition system and development of intervention plan requires significant resources beyond the currently available funding and therefore, the scope of this study was kept limited as presented in this paper.

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References

Anderson, Elizabeth. (2017). Measurement of Online Student Engagement: Utilization of Continuous Online Student Behaviors as Items in a Partial Credit Rasch Model. *Electronic Theses and Dissertations, 1248*.

Blumenfeld, Phyllis, & Paris, AH. (2004). School Engagement: Potential of the Concept, State of the Evidence. *Review of Educational Research - REV EDUC RES, 74*, 59-109. https://doi.org/10.3102/00346543074001059

Christenson, L., Sandra, Reschly, L., Amy, WYLIE, CATHY, & Widiasani, Azkananda. (2012). *Handbook of Student Engagement*. https://doi.org/10.1007/978-1-4614-2018-7

Chen, X. (2013). *STEM Attrition: College Students' Paths into and Out of STEM Fields* (NCES 2014-001). National Center for Education Statistics, Institute of Education Sciences, U.S. Department of Education. Washington, DC.

Fredricks, Jennifer, Mccolskey, Wendy, Manweiler, Jane, Mordica, Joy, Montrosse-Moorhead, Bianca, & Mooney, Kathleen. (2011). Measuring Student Engagement in Upper Elementary through High School: A Description of 21 Instruments. *Issues & Answers,* REL 2011-No. 098. Regional Educational Laboratory Southeast.

Fredricks, Jennifer A., & Wendy McColskey. (2012). The Measurement of Student Engagement: A Comparative Analysis of various Methods and Student Self-Report Instruments. *In. 2012th ed.,* 763-782. Boston, MA: Springer US. https://doi.org/10.1007/978-1-4614-2018-7_37

Greene, Barbara A. (2015). Measuring Cognitive Engagement with Self-Report Scales: Reflections from Over 20 Years of Research. *Educational Psychologist, 50*(1), 14-30. https://doi.org/10.1080/00461520.2014.989230

Greenwood, Charles, Horton, B.T., & Utley, C.A. (2002). Academic engagement: Current perspectives on research and practice. *School Psychology Review, 31*, 328-349.

Gunes, Hatice, & Piccardi, Massimo. (2006). *A Bimodal Face and Body Gesture Database for Automatic Analysis of Human Nonverbal Affective Behavior, 1*, 1148-1153. https://doi.org/10.1109/ICPR.2006.39

Henrie, Curtis R., Lisa R. Halverson, & Charles R. Graham. (2015). Measuring Student Engagement in Technology-Mediated Learning: A Review. *Computers & Education, 90*, 36-53. https://doi.org/10.1016/j.compedu.2015.09.005

Hart, Shelley R., Kaitlin Stewart, & Shane R. Jimerson. (2011). The Student Engagement in Schools Questionnaire (SESQ) and the Teacher Engagement Report Form-New (TERF-N): Examining the Preliminary Evidence. *Contemporary School Psychology, 15*, 67-79. https://doi.org/10.1037/t42908-000

O'Malley, Kimberly J., Betty Jeanne Moran, Paul Haidet, Charles L. Seidel, Virginia Schneider, Robert O. Morgan, P. Adam Kelly, & Boyd Richards. (2003). Validation of an Observation Instrument for Measuring Student Engagement in Health Professions Settings. *Evaluation & the Health Professions, 26*(1), 86-103. https://doi.org/10.1177/0163278702250093

Reschly, A. L., & Christenson, S. L. (2012). Jingle, Jangle, and Conceptual Haziness: Evolution and Future Directions of the Engagement Construct. In S. L. Christenson, A. L. Reschly, & C. Wylie (Eds.). *Handbook of Research on Student Engagement* (pp. 3-19). New York: Springer. https://doi.org/10.1007/978-1-4614-2018-7_1

Rautaray, Siddharth, & Agrawal, Anupam. (2012). Real Time Multiple Hand Gesture Recognition System for Human Computer Interaction. *International Journal of Intelligent Systems and Applications, 4*. https://doi.org/10.5815/ijisa.2012.05.08

Sariyanidi, Evangelos, Gunes, Hatice, & Cavallaro, Andrea. (2014). Automatic Analysis of Facial Affect: A Survey of Registration, Representation, and Recognition. *IEEE Transactions on Pattern Analysis and Machine Intelligence*. https://doi.org/10.1109/TPAMI.2014.2366127

Volpe, Robert, DiPerna, James, & Hintze, John. (2005). Observing Students in Classroom Settings: A Review of Seven Coding Schemes. *School Psychology Review, 34*.

Appendix I. Bimodal Face and Body Gesture Database (FABO)

No	Body gesture	Expression
1.	Hands on Table	Neutral
2.	Closed hands/clenched fist, shake the finger/hand, crossing the arms	Anger
3.	Right/Left hand moving towards the head, two hands touching the face/mouth, both hands over the head, self-touch two hands covering cheeks, mouth	Surprise
4.	Body Contracted. Arm around body. Hand covering face, head, or neck	Fear
5.	Hand pressed together in a moving sequence, tapping the tips of fingers on the table	Anxiety
6.	Body extended, hand clapping, arms lifted up or away from the body with hands made into fists	Happiness
7.	Hands close to the body, hands covering the head, neck, right/left hand on the mouth	Disgust
8.	Body shift, change orientation, move to the right/left, hand behind the head, below chins, elbow on table	Bored
9.	Contracted/closed body, dropped shoulders, bowed head, body shift-forward leaning trunk, covering face with two hands, hands kept lower that normal etc.	Sadness

Appendix II. Behavior Observation Cycle

Time	Unit	Behavior	Directed to whom?	Comments.
	Instructor	Talk, Listen/monitor, Read, Organize, other	Entire class, Subgroup individual	
	Student 1	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student, Self/notes	
	Student 2	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student, Self/notes	
	Student 3	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student, Self/notes	
	Student 4	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student, Self/notes	
	Student 5	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student, Self/notes	
	Student 6	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student, Self/notes	
	Student 7	Talk, Listen/monitor, Read, Organize, other	Instructor, Group Student Self/notes	

Appendix III. Student Self-Assessment of Classroom Engagement Questionnaire

Date:

Class Standing: ☐ Freshman ☐ Sophomore ☐ Junior ☐ Senior

Gender: ☐ Female ☐ Male

First generation student: ☐ Yes ☐ No

Ethnicity: ☐ White
☐ American Indian or Alaska Native
☐ Asian
☐ Black or African American
Native Hawaiian or other Pacific Islander
☐ Hispanic or Latino

Q.N.	Item	Strongly Disagree	Disagree	Neutral	agree	Strongly Agree
1.	I contributed meaningfully to class discussions today.					
2.	I was not paying attention most of the time in class.					
3.	I contributed my fair share to class discussion.					
4.	I participated in class discussion today.					
5.	I talk in class with other students about class material.					
6.	I was mostly a passive learner in class today.					
7.	I paid attention most of the time in class.					
8.	I was mostly an active learner in class today.					
9.	Most students were actively involved in class today.					