Research on Measuring and Analyzing Student Engagement in Classes across University

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Abstract

The National Survey of Student Engagement (NSSE) was especially designed to measure student engagement as a means of evaluating the impact of education at the university level. However, no such simple tool is available for measuring student engagement at an individual class level. This paper describes a classroom survey of student engagement (CSSE) that was adopted from the original NSSE Survey. The CSSE survey conducted over five semesters examined levels of student engagement in 539 classes from the first year to graduate level. Of 17,660 students enrolled in those 539 courses, 13,441 students completed the survey. Results showed more engagement in higher-level classes and also in those classes with fewer students. The study also compared results with the NSSE. Other instructors can use the instrument and the reported results to measure and compare the engagement levels in their classes.

Introduction

Engaging students in the process of learning is one of the important goals of educators. Johnson[1] noted that providing all knowledge in a passive manner to students is the old paradigm. The new paradigm is to actively engage students with the material and one another. Physics education research shows a two-sigma difference in understanding of main concepts between a group of students taught using interactive engagement methods and a group of traditionally taught students.[2] In addition, national studies are examining alternative teaching and evaluation of university effectiveness in an effort to further understand and improve education.[3,4]

Hake[2] conducted a pioneer study in physics education using over 6000 students for understanding the effectiveness of interactive engagement (IE). Hake[2] defines the IE methods as those designed to gain a conceptual understanding through heads-on (always) and hands-on (usually) activities that result in immediate feedback with peers and instructors. It was found that the IE methods had an average gain of 0.48±0.14 SD, which was two standard deviations above the traditional course which received an average gain of 0.23±0.04 SD. Hake[5] summarized that "the use of interactive engagement (IE) strategies can increase the effectiveness of conceptually difficult courses well beyond that obtained with traditional methods."

However, there are few studies conducted on the measurement of student engagement at class level across the whole educational institution. Mehta and Kou demonstrated that the IE method in statics class is superior to the traditional teaching methods using the Math-Statics Baseline

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(MSB) test, the student engagement survey, and the Individual Development and Educational Assessment (IDEA) analysis.[6] By examining the performance of over 600 students over three semesters, they found that by using IE methods and creating an appropriate learning environment, the gain in student understanding can be enhanced from about 23% to 42%, and student attendance and passing rates can be increased by over 30%. Ahlfeldt, Mehta, and Sellnow[7] conducted the measurement and analysis of student engagement at a class level across the whole university. Their data are based on the survey of 56 classrooms and 1831 students in spring 2001. The results showed a higher engagement in higher-level classes and also those classes with fewer students. In addition, the level of engagement was typically higher in those classrooms with more Problem-Based Learning (PBL). This paper is a followup study of Ahlfeldt et al's research and reports the whole university student engagement level in classrooms in five consecutive semesters from spring 2001 to spring 2003.

Research context and method

Participants and Procedure

This study is a campus-wide project to survey the student engagement at a class level. From spring 2001 to spring 2003, there are five semesters in total covered in the survey. At the end of each semester, the students were asked to fill out an engagement survey, which is described below. In total, 17,660 students registered in 539 classes spanning six colleges in the institution. Among all of the students registered in the class, 13,441 of them responded to the survey, resulting in a response rate of 76%.

Survey instrument

The survey of student engagement was developed using the National Survey of Student Engagement.[4] The National Survey of Student Engagement (NSSE)[4] is an ongoing research campaign in the USA used to assess the extent to which colleges and universities are participating in educational practices that are strongly associated with high levels of learning and personal development. NSSE data focus on something far more important, namely how students use resources for learning. The survey examines the environment of college students, but is also intended to foster a particular way of thinking and talking about collegiate quality.[8] In our classroom survey of student engagement (CSSE), key questions were selected based on their measurability of student engagement at the classroom level in the categories of cooperative learning, cognitive development, and personal skills development. Only 14 questions were chosen in order to create a modest size survey that was appropriate for quick distribution in a variety of different courses (see Appendix).

Results

Reliability

The CSSE instrument used for testing different categories of engagement and the relationships between these categories was highly reliable. Reliability for CSSE was determined by using a statistical analysis program, SPSS. The alpha reliability for the 14-item instrument was 0.84.

Demographics

Demographic characteristics about the sample were used to provide results for the study. Course level was coded using 1 for all 100 (freshman)-level courses, 2 for all 200 (sophomore)-level courses, 3 for all 300 (junior)-level courses, 4 for all 400 (senior)-level courses, 5 for all 500 professional level courses, and 6 and 7 for graduate level courses. The mean course level was 2.4 with a standard deviation of 1.6. Enrollment was based on the third-week enrollment of students in each class that took the survey. Enrollment ranged from 1 to 430. The mean was 32.7, with a standard deviation of 42.7. The surveys were completed by 13,441 students in those classes (76% response rate). The mean response was 24.9 with a standard deviation of 27.8.

For each participating class, its academic college was also noted to determine the distribution of engagement score (ES) across disciplines. The colleges were coded as follows: 1, Agriculture; 2, Arts, Humanities, and Social Sciences; 3, Business Administration; 4, Engineering and Architecture; 5, Human Development and Education; 6, Pharmacy; and 7, Science and Mathematics.

The ES was obtained by summing the 14 responses on the survey (with question 5 response reversed). The mean ES was 37.1, with a standard deviation of 4.2. The range of ES was 25 to 51.

Table 1 provides descriptive statistics concerning demographic characteristics about the sample:

1. Course Level;
2. Enrollment;
3. Academic college;
4. Engagement score.

Table 1 Descriptive statistics of variables

	N	Mean	Standard Deviation	Range
Course Level	539	2.4	1.6	1, 7
Enrollment	539	32.7	42.7	1, 430
College	539	3.2	1.8	1, 7
Engagement Score	539	37.1	4.2	25, 51

Note: N is the number of courses.

The distributions of classes based on course levels, enrollment, and colleges are given in tables 2 to 4.

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Table 2 Distribution of classes based on course levels

Course Level	Number of Classes
1	246
2	55
3	98
4	103
5	7
6	10
7	20
University Total	539

Table 3 Distribution of classes based on enrollment

Enrollment	Number of Classes
<=10	43
11-30	355
31-50	87
51-100	25
101-200	21
201-300	4
>300	4
University Total	539

Table 4 Distribution of classes based on colleges

Colleges	Number of Classes	Enrollment		Class Level	
		Average	S.Dev	Average	S.Dev
1	28	26.07	22.74	3.32	1.47
2	271	20.71	10.76	1.67	1.32
3	37	46.32	37.78	3.35	1.51
4	83	37.54	35.09	3.29	1.06
5	50	35.92	37.41	3.62	1.81
6	8	41.13	20.09	4.50	0.76
7	62	70.37	96.92	2.21	1.54
University	539	32.7	42.7	2.4	1.6

Engagement Level

By totaling the scores from questions 1 through 4, a cooperative learning category was created. The average scores in the unit of each class ranged from 5.2 to 14.9, with the university-wide mean of 9.6 and standard deviation of 1.4. The cognitive-level category was created by combining questions 5 through 9. It is noted that question 5, which is a question about the amount of memorization of class material, was recoded (1 became 4, 2 became 3, 3 became 2, and 4 became 1). Memorization of material would not increase classroom engagement and was

reversed to provide an accurate ES when statistical tests were run. The scores for cognitive category ranged from 10 to 19.1 in different classes. The mean at university level was 13.8 with a standard deviation of 1.6. The final category, personal skills, was created by combining question 10 through 14. These averages ranged from 7.7 to 19.1 in different classes. The university level mean was 13.7 with a standard deviation of 1.8.

Table 5 reports the responses to the three groupings of variables, along with the results of the engagement score:

1. Cooperative learning;
2. Cognitive level;
3. Personal skills;
4. Engagement score.

Table 5 Responses to engagement in different categories

	Possible range of scores		Mean	Standard Deviation
	Min.	Max.		
Cooperative Learning	4	16	9.6	1.4
Cognitive Level	5	20	13.8	1.6
Personal Skills	5	20	13.7	1.8
Engagement Score	14	56	37.1	4.2

Note: Comparison variables: Very often or very much = 4; Often or quite a bit = 3; Occasionally and some = 2; Never and very little = 1.

Comparison with National Survey of Student Engagement

The results of this survey were compared to those of the National Survey of Student Engagement (NSSE)[4] from 2000, which was administered to over 62,000 students. The NSSE had an average ES of 38 (see Table 6). The institution where this study was administered had an ES of 37. Table 6 reports the means from the NSSE national study[4] from 2000. Means are reported for each grouped category (cooperative learning, cognitive level, and personal skills) for the institution where this study was conducted, for doctoral levels I and II institutions nationally, and for undergraduates nationally. Each institution focus is divided into three groups including first-year students, seniors, and the total. Additionally, the number for each group and the mean ES is also listed.

Table 6 Results of National Survey of Students Engagement (2000)[4]

	This institution			Doctoral Levels I & II			National		
	First Year	Senior	Total	First Year	Senior	Total	First Year	Senior	Total
Number of Students	208	238	446	2889	3027	5916	30635	32193	62828
Cooperative learning	8.77	10.11	9.49	9.09	9.88	9.50	9.24	10.13	9.70
Cognitive level	11.90	13.20	12.60	12.93	13.82	13.38	13.06	14.05	13.56
Personal skills	13.33	15.38	14.43	13.90	15.37	14.66	14.17	15.64	14.93
Engagement score	34.01	38.70	36.51	35.92	39.08	37.54	36.47	39.82	38.19

Correlations between demographic characteristics and categories of engagement

The ES was correlated to class level (freshman to graduate), class size, and academic college. Our hypotheses were: 1) As course level increases, the engagement level increases; and 2) As class enrollment decreases, the engagement level increases. Both hypotheses were supported. Using a plot in Figure 1, the correlation of ES as a function of class level is illustrated. The correlation between these two variables was +0.37 ($p<0.001$), indicating that as class level increases, ES also increases. The NSSE 2000 data also support this hypothesis as the engagement scores in all categories in Table 6 are higher for seniors compared to the scores for freshmen.

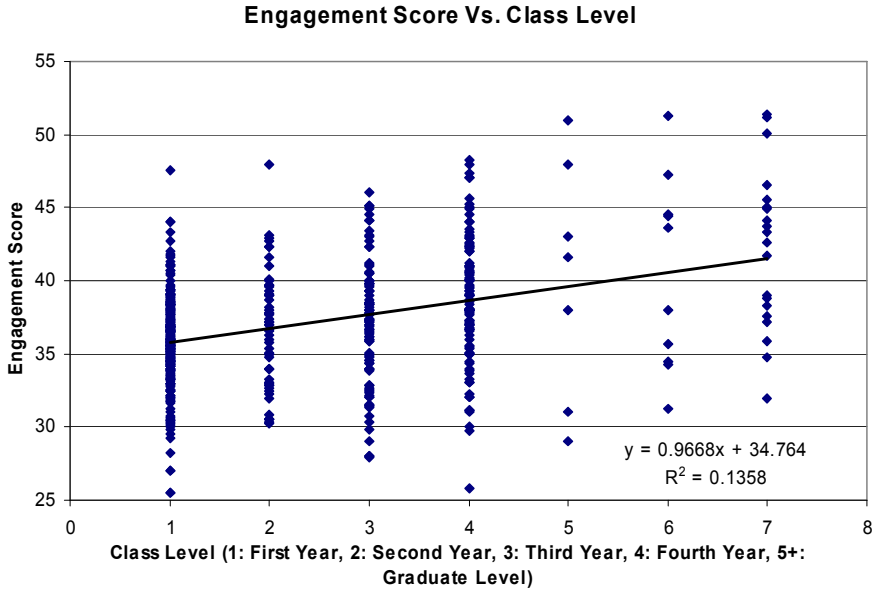

Figure 1 As level of course content increases, engagement increases

Figure 2 plots the correlation of ES as a function of class size. As class size decreases, the engagement level increases (-0.32 correlation, $p<0.001$). The regression lines in both figures 1 and 2 show the general trend of variation of the engagement scores with class levels and enrollment. At present, the analysis is done using one variable at a time. Multiple regressions and some other factor-based analysis will be done in the future.

Figure 3 plots the distribution of ES for each college at the university. The College of Pharmacy, the College of Human Development and Education, and the College of Engineering and Architecture had in general high scores. The College of Business Administration and the College of Science and Mathematics had typically low scores.

The additional information showing the distribution of enrollment, course level, and engagement scores in each college and the university averages have been provided in Table 4 and Table 7.

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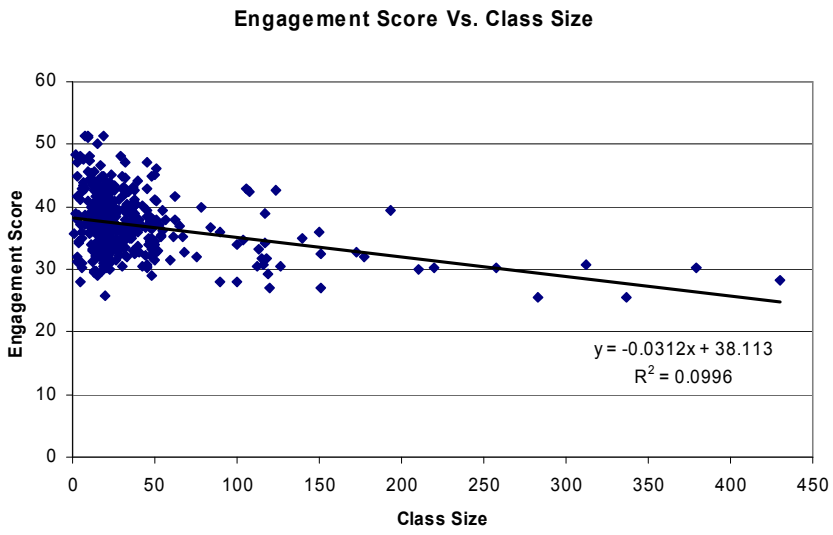

Figure 2 The smaller the class size, the higher the engagement level

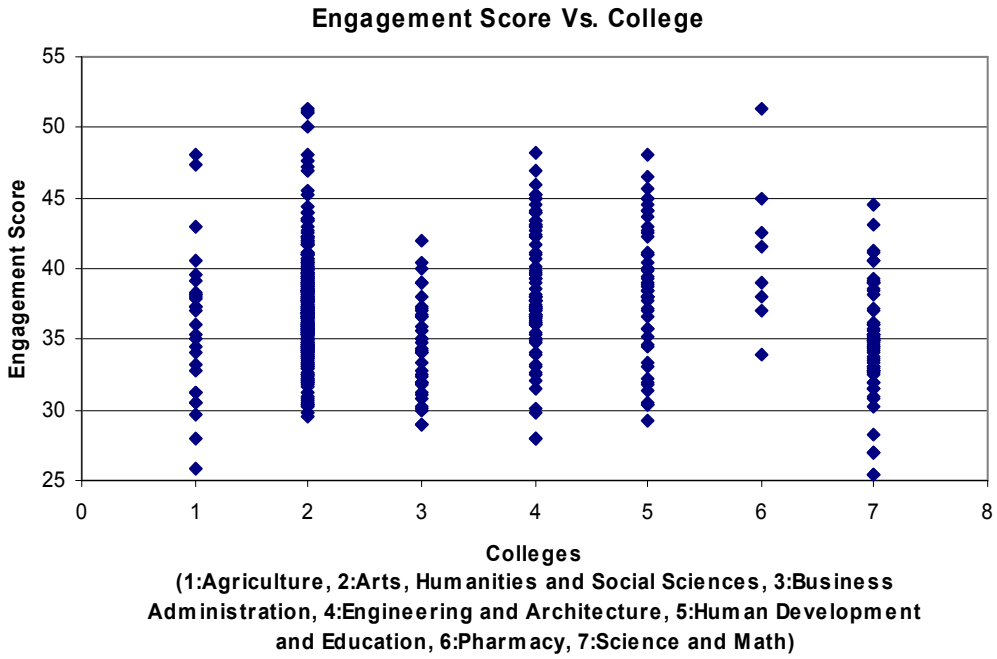

Figure 3 Distribution of engagement scores, by college

Correlations between categories

As mentioned earlier, the instrument consisted of three blocks of measures. Block A was used to measure the level of collaborative learning, Block B measured levels of cognitive complexity, and Block C measured the development of personal skills. All three categories were positively correlated with one another. Cognitive development and collaborative learning (blocks B and A) had a +0.53 correlation. Personal skills and collaborative learning (blocks C and A) had a correlation of +0.62. Finally, personal skills and cognitive development (blocks C and B) had a

+0.71 correlation. These correlations reveal a strong interdependence among the groupings and all were statistically significant ($p<0.001$).

Table 7 Distributions of engagement score in each college

Colleges	Cooperative Learning		Cognitive Level		Personal Skills		Engagement Score	
	Average	S.Dev	Average	S.Dev	Average	S.Dev	Average	S.Dev
1	9.26	1.77	13.38	1.71	13.40	2.29	35.98	5.19
2	9.74	1.22	13.72	1.53	13.87	1.51	37.32	3.67
3	8.73	1.56	13.20	1.12	12.52	1.54	34.41	3.37
4	9.99	1.50	14.28	1.55	14.14	1.72	38.43	4.33
5	9.70	1.62	14.30	1.82	14.47	1.87	38.47	4.74
6	10.61	1.82	14.99	1.68	15.42	2.43	41.03	5.39
7	8.71	1.34	13.41	1.20	12.54	1.69	34.78	3.91
University	9.57	1.45	13.79	1.55	13.72	1.77	37.10	4.2

Discussion

A simple instrument was developed to measure student engagement at class level. The total ES was based on three groupings of questions designed to learn more about the levels of cooperative learning, the levels of cognitive challenge, and the development of personal skills. In testing these categories with one another, it was revealed that they are all highly correlated and statistically significant, which is compliant with the published data using the same instrument.[7]

The averages obtained using the CSSE instrument are consistent with the averages obtained using the NSSE instrument. The CSSE instrument can be used by other instructors to measure the engagement levels in their classes and compare their engagement levels with the engagement levels provided in Table 7.

This study, similar to Ahlfeldt et al's[7] study, suggests that class size and class level do impact student engagement, but only to a small extent. By using several methods of active cooperative learning, as suggested in the literature,[9, 10] even in large and/or lower division classes, students can be engaged at a higher level. Ahlfeldt et al[7] have reported that by using the problem-based learning (PBL) appropriately across the whole university, the student engagement and development of cognitive and personal skills can be enhanced. Hence, when using such methods, it is important to provide opportunities to all students to experience engaged instruction irrespective of class level, class size, and discipline.

As suggested by Hake,[5] every subject should have high quality standardized tests like the Force Concept Inventory to measure the impact of teaching methods on student learning. Development of such reliable tests can take several years. Hence, in the mean while, this classroom level survey can be used to measure and enhance the impact of teaching methods on student development and learning.

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Biography

SUDHIR MEHTA, Ph.D., is a professor of Mechanical Engineering at North Dakota State University (NDSU). He received numerous awards from the NDSU and professional societies, including the ASEE, and several grants from the NSF, 3M, and HP to enhance engineering education. He is a Fellow Member of the ASEE, and co-author of the courseware, "Statics: The Next Generation," which is electronically published by Prentice-Hall in August 2001.

ZHIFENG KOU is a Ph.D. candidate in Mechanical Engineering and a Master degree student in Computer Science at North Dakota State University. His research interests are biomechanics of head/neck injury, bioinstrumentation, neuro-engineering, medical informatics, telemedicine and e-health, and engineering education. He is a student member of the ASEE and authored various journal and conference papers in his concentration areas.

Appendix The Form of Student Engagement Survey

A Survey of Student Engagement

Course Number: _____ **Instructor:** _____

Please cross (X) your answers.

A. During your class, about how often have you done each of the following?
Scale: 4: very often; 3: often; 2: occasionally; 1: never

1. **Asked questions** during class or contributed to class discussions	4	3	2	1
2. **Worked with other students** on projects during class time	4	3	2	1
3. **Worked with classmates outside** of class to complete class assignments	4	3	2	1
4. **Tutored or taught** the class materials to other students in the class	4	3	2	1

B. To what extent has this course emphasized the mental activities listed below?
Scale: 4: very much; 3: quite a bit; 2: some; 1: very little

5. **Memorizing** facts, ideas or methods from your course and readings so you can repeat them in almost the same form	4	3	2	1
6. **Analyzing** the basic elements of an idea, experience or theory such as examining a specific case or situation in depth and considering its components	4	3	2	1
7. **Synthesizing and organizing** ideas, information, or experiences into new, more complicated interpretations and relationships	4	3	2	1
8. **Evaluating** the value of information, arguments, or methods such as examining how others gathered and interpreted data and assessing the accuracy of their conclusions	4	3	2	1
9. **Applying** theories and/or concepts to practical problems or in new situations	4	3	2	1

C. To what extent has this course contributed to your knowledge, skills, and personal development in the following ways?
Scale: 4: very much; 3: quite a bit; 2: some; 1: very little

10. **Acquiring job or career related** knowledge and skills	4	3	2	1
11. **Writing** clearly, accurately, and effectively	4	3	2	1
12. **Thinking** critically and/or analytically	4	3	2	1
13. **Learning effectively on your own,** so you can identify, research, and complete a given task	4	3	2	1
14. **Working effectively with other individuals**	4	3	2	1

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