In Higher Education, Class Size Matters

Stephen L. Benton, Dan Li, and William H. Pallett

The IDEA Center

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Abstract: Student ratings were compared in college and university courses that varied by class size (small, medium, large, very large, and 101+) and by whether the discipline was designated as science, technology, engineering, and mathematics (STEM) or non-STEM. Data from 490,333 classes in over 400 institutions were accessed from archived files of the IDEA Student Ratings of Instruction system. Students in small classes reported the most progress on relevant objectives, the strongest desire to take the course, and the most effort. Students in small and medium classes reported more teacher attempts to foster collaboration, establish rapport, and stimulate student interest than those in larger classes; they also believed the instructor expected them to take a greater share of their responsibility for learning. Findings are discussed within the context of the relationship between class size and the theory of transactional distance.

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During the debates of the 2012 presidential campaign, the issue of class size entered the fray within the context of U.S. global competitiveness. Although the candidates primarily weighed the benefits of small classes in the K-12 setting, the topic is also worthy of discussion within higher education. With the growth of online classes, including massive open online courses (MOOCs), and education cuts caused by the nation's economic situation, it is vital to reassess the effects of class size in college courses. In this paper, we investigated whether students' self-reported progress varies in classes of different sizes. Also, we employed the Theory of Transactional Distance as a theoretical framework to illuminate relationships between class size and the three factors of transactional distance and their determinants: dialogue, structure, and learner autonomy. Specifically, we examined whether uses of certain teaching methods to improve student understanding vary, depending upon class size. Also, do students exhibit similar levels of autonomy in terms of their motivation and work habits in large classes compared to smaller classes?

Effects of Class Size on Teaching Effectiveness and Academic Achievements

Researchers have investigated the relationship between class size and teaching effectiveness and have not reached consensus. Earlier studies tended to discover a weak negative association in a non-linear manner with ratings in small and large courses being higher than those in medium-sized classes (Feldman, 1984; Wood, Linsky, & Straus, 1974), with a few exceptions (Wigington, Tollefson, & Rodriguez, 1989). A recent study (Bedard & Kuhn, 2008) discovered a significant negative effect of class size on students' ratings of teaching effectiveness. However, the relationship was non-linear--the negative impact was stronger for smaller classes and grew weaker as class size increases. Despite the inconsistency in findings, one can conclude there is no positive relationship between class size and student ratings (Feldman, 1978).

Historically, research findings on the effects of class size on student achievement in post-secondary education are also equivocal. Some have found no significant impact (e.g., Pascarella & Terenzini, 1991); others have discovered that student achievement declines slightly as class size increases (e.g., Feldman, 1984). But such studies predate the widespread development of online classes with very large enrollments. More recently, Centra (2009) found that students in smaller classes reported learning more. But, medium-sized classes have been found to have little to no benefit over large classes with respect to undergraduate student learning and achievement in mathematics; however, student engagement is stronger in small classes (Gleason, 2012).

Other course and student characteristics might moderate the relationship between class size and student achievement. Studies have reported a general negative impact from class size that varies across disciplines (Kokkelenberg, Dillon, & Christy, 2008). For example, in a study within an Italian public university DePaola (2013) found that class size had a negative relationship with students' performance in mathematics, whereas such an effect did not exist for language skills classes. Similarly, in a study conducted at a U.S. public research university, student performance was negatively related with class size across all disciplines, and such an association was generally more pronounced in hard and pure disciplines (Johnson, 2010). Lindsay and Paton-Saltzberg (1987) reported in their study of a British polytechnic that class size was negatively correlated with students' academic performance in all disciplines except those for vocational training. In summary, disciplines concerning science and technology seem to be more vulnerable to negative impact from larger class size. In this study, we examined whether the effects of class size on student performance are different between science, technology, engineering, and mathematics (STEM) and non-STEM fields.

Another course characteristic that may play a role in affecting the impact of class size on academic performance is course level. Advanced courses usually emphasize higher level of cognitive skills and thus are more vulnerable to reduction of more engaging activities in larger classes (Raimondo, Esposito, & Gershenberg, 1990). With respect to distance education, class size may matter less than students' reasons for taking the course and their class status (i.e., lower-level vs. upper-level students) (Liu, 2012). However, only 1.3% of Liu's (2012) sample included classes with over 35 students. In this study, we took into account the impact of course level when examining the effects of class size on student progress. *Theory of Transactional Distance*

To understand the relationship between class size, teaching, and learning from a theoretical perspective, we turned to the Theory of Transactional Distance (Moore, 1993). Transactional distance (hereinafter referred to as "TD") is defined as the "psychological and communication space to be crossed, a space for potential misunderstanding between the inputs of instructor and those of the learner." (Moore, 1993, p. 22) Research has found TD to be negatively related with perceived teaching effectiveness in distance education programs (Lemak, Shin, Reed, & Montgomery, 2005). Although the theory was originally developed for distance education, the concept of TD is applicable in any instructional context, either face-to-face or online (Rumble, 1986). For instructors, minimizing TD is key to increasing learner understanding and outcomes. In this study, we examined whether the three components of TD and their determinants vary by class size.

Moore (1993) identified three determinants of TD: *dialogue, structure,* and *learner autonomy*. Dialogue and structure address specific teaching practices, whereas learner autonomy focuses on learner behaviors. The theory of Theory of Transactional Distance further explores factors that determine these variables. In this study, we identified indicators of each determinant we perceived to exist in items and subscales of the IDEA Student Ratings of Instruction (SRI) system.

Dialogue. Dialogue denotes positive student-instructor interactions that improve students' understanding (Moore, 1993). Instructors can reduce TD by increasing dialogue. Establishing Rapport, a teaching style measured by four relevant teaching methods in the IDEA instrument, measures student perceptions of student-instructor interaction. Fostering Student Collaboration, another teaching style composed of three specific teaching methods, assesses dialogue *among* students (see Appendix A for individual items related to these scales). Both teaching styles encourage student engagement and should promote dialogue, which reduces TD.

Moore (1993) identified a series of factors that affect dialogue. Among them, class size is of particular relevance in this study. Class size can negatively influence dialogue in two ways. First, instructors tend to use lectures when teaching in large class settings (McKeachie, 1978). Although lectures are appropriate for acquiring factual knowledge, they do not leave much "space" for student-instructor interaction. Secondly, larger class sizes mean less teaching resources on average available for students, which can be translated into lower frequency and quality of interaction with instructors (see Cuseo, 2007). In contrast, instructors teaching smaller classes are more likely to engage students in course participation (Haslett, 1976). Therefore, we hypothesized that instructors teaching smaller classes are more likely to establish rapport and foster student participation.

Moore (1993) also notes that the learner's emotional status can affect the dialogue. Specifically, learners with stronger motivation tend to get involved in more dialogue with instructors and peers than do those who are less motivated. Bolander (1973) reported that class size was negatively related with students' motivation level. In this study, we expected the same negative relationship to be present in our database.

Because academic discipline can affect the teaching approach an instructor employs (Braxton, Olsen, & Simmons, 1998; Cashin & Downey, 1995; Hoyt & Lee, 2002; Umbach, 2007), subject matter might also influence dialogue (Moore, 1993). STEM subject-matter tends to be hierarchical and highly structured and therefore instruction tends to be more teacher-centered (Lueddeke, 2003), which would lead to less student-instructor interaction. In non-STEM fields, instructors tend to emphasize active learning strategies (Braxton et al., 1998; Lattuca & Stark, 1995), which should value dialogue. They are more likely to employ a student-centered approach (Lueddeke, 2003); they interact with students, communicate high expectations, and ask questions (Braxton et al., 1998; Umbach, 2007).

In this study, then, we examined STEM differences in dialogue because instructors in those fields tend to be more teacher-centered, whereas those in non-STEM disciplines are generally more student-centered. We also wanted to know whether class size effects would be different in both the STEM and non-STEM courses.

Structure. The second element of TD represents the course design and the extent to which it is flexible enough to accommodate individual learner needs (Moore, 1993). Programs that are highly structured and with little dialogue permitted tend to have greater TD. Moore (1993) specified five structural processes characterized in distance programs: presentation, motivation, analytic and critical development, application and evaluation, and learner support. While the

IDEA instrument does not contain direct measures of structure, we identified two teaching styles that cover four of the five structural processes: Stimulating Student Interest (motivation) and Structuring Classroom Experience (presentation, application, and evaluation) (see Appendix A). Accordingly to the theory, practicing such styles should lead to lower TD. We were particularly interested in whether class size interacts with discipline type (STEM, non-STEM) its relationship with teaching styles, so that we can further our understanding of the relationship between class size and TD.

Learner autonomy. Whereas the previous two TD concepts emphasize instructors' teaching practices, learner autonomy focuses on students in learning experience. Autonomy is the extent to which the learner independently decides on learning goals and course experiences, as well as preparing for evaluation (Moore, 1993). The greater the TD, the more autonomous one needs to be (Moore, 1991). We identified three items in the IDEA instrument related to this concept: student perceptions of their typical work habits, perceived effort in the course, and how much the instructor expects them to share in responsibility for learning. According to the theory, high scores on the three items should indicate higher learner autonomy, which implies lower TD. While we did not measure those relationships in this study directly, we examined whether the three measures of autonomy vary by class size and STEM versus non-STEM designation.

Method

Data Source

The unit of analysis was ratings aggregated at the class level. Archived data were accessed and analyzed from student ratings of instruction collected in courses using the IDEA Student Ratings of Instruction system. Developed from a grant awarded in 1975 from the Kellogg Foundation, the IDEA SRS is the oldest and most widely researched student ratings instrument. The IDEA Center is a nonprofit organization that has as part of its mission supporting the improvement of learning and teaching through the use of its diagnostic student ratings instrument.

Student ratings from 490,196 undergraduate (89%) and graduate (11%) classes were collected in 2002-2011 from over 400 colleges and universities in all regions of the continental U.S. Approximately 40% came from masters level institutions, 20% each from bachelors and doctoral level, 5% from associate, and 5% other.

Instrumentation

Faculty Information Form. Instructors complete the *Faculty Information Form* (FIF) for each course evaluated within the system.[1] A class was included in the IDEA database only if the instructor completed the FIF. Instructors rate each of 12 learning objectives as 3 (*Essential*), 2 (*Important*), or 1 (*of Minor or No Importance*); at least one objective must be rated as either essential or important. There are optional contextual questions about instructional approaches and course characteristics (e.g., principal type of student enrolled in class, size of enrollment, discipline). Class size was defined as the number of students enrolled in the course as reported by the instructor on the FIF. STEM courses were identified, using the STEM-Designated Degree Program List set by the Immigration and Customs Enforcement arm of the U.S. Department of Homeland Security (http://www.ice.gov/sevis/stemlist.htm).

Student Ratings Form. The IDEA *Student Ratings of Instruction Diagnostic Form* is a 47-item instrument.[2] Students indicate how frequently their instructor used each of 20 teaching methods, by responding 1 (*Hardly Ever*), 2 (*Occasionally*), 3 (*Sometimes*), 4 (*Frequently*), or 5 (*Almost Always*). The 20 teaching methods are organized into five teaching styles based on factor

[1] http://www.theideacenter.org/sites/default/files/Student-Ratings_Faculty_Information_Form.pdf.
[2] http://www.theideacenter.org/sites/default/files/Student_Ratings_Diagnostic_Form.pdf.

analysis (Hoyt & Lee, 2002) (see Appendix A). Students also rate their progress on each of the same 12 learning objectives their instructor rated for importance. Students respond with 1 (*No apparent progress*), 2 (*Slight progress*), 3 (*Moderate progress*), 4 (*Substantial progress*), or 5 (*Exceptional progress*). In the IDEA class report, a weighted mean is reported by double weighting ratings on objectives the instructor identifies as "essential" and single weighting those that are "important." This provides an average rating of student progress on relevant objectives. Additional questions concern course and student characteristics (i.e., work habits, motivation, effort). Finally, students report overall excellence of the course and instructor, and use of other teaching methods and instructor standards. The scale for these items ranges from 1 (*Definitely false*) to 5 (*Definitely true*). For information on validity and reliability research conducted on the instrument, see Hoyt and Lee (2002).

Statistical Analyses

In comparing STEM versus non-STEM courses, we conducted a series of 2 x 2 MANOVAs of Class Size by STEM Designation (STEM, non-STEM). Historically, the IDEA Center has categorized class size as small (10-14), medium (15-34), large (35-49), and very large (50+) when preparing technical reports (Hoyt & Lee, 2002). Classes with enrollments less than 10 are deleted from the IDEA research database because the reliability of scores is lower. Those groupings were considered appropriate based on data collected from 1998 to 2001 when large enrollments were less common in the IDEA database. However, for the purposes of this study, we changed the "very large" category to range from 50 to 100 and added a fifth group of "greater than 100." This resulted in the following distribution of classes: small (n = 63,622), medium (n = 349,313), large (n = 48,916), very large (n = 21,405), and > 100 (n = 6,098).

Dependent measures. The three sets of dependent measures addressing TD were analyzed separately. Dialogue included student ratings of their desire to take the course regardless of who taught it as well as the IDEA teaching style scales of fostering student collaboration and establishing rapport. Structure was comprised of the scales stimulating student interest and structuring the classroom experience. Learner autonomy included student ratings of their effort in the course, their typical work habits, and instructor expectations that students share in responsibility for learning. To examine whether class size and STEM designation affect and indirect measure of learning outcomes, we also analyzed average student progress on relevant objectives.

Given the large sample sizes, Type I error rate was set at $\alpha = .001$. In ord not to call attention to trivial effects, we set a criterion of partial $\eta^2 \geq .01$ to distinguish between meaningful and non-meaningful univariate effects. We computed Cohen's *d* on pairwise comparisons to identify mean differences of at least a medium effect (*d* = .50) or about one-half standard deviation, as defined by Cohen (Cohen, 1992). Mean differences meeting our criteria were deemed to be of practical significance.

Results

Table 1 presents pooled Pearson *r* correlations between the dependent measures. Tables 2, 3, and 4 present means and standard deviations for each of the TD indicators by class size and by STEM designation.

Correlations between Dependent Measures

As shown in Table 2, each indicator of TD showed either a positive moderate or strong relationship with student self-reported progress on relevant learning objectives. Ratings of teacher behaviors (fostering collaboration, establishing rapport, stimulating interest, structuring the classroom) were more strongly related to student progress than were student self-ratings of their own behaviors (desire to take course, effort, and typical work habits).

Class Size by Student Level

Before addressing the research questions, we first conducted 3 x 5 Student Level (lower-level, upper-level, graduate) by Class Size MANOVAs on each of the three groups of TD indicators. This was done to see if effects of class size depended on student level. Using the criterion we set for meaningfulness, none of the two-way interactions were considered more than trivial. All partial η^2 values were less than .01. We concluded, therefore, that the effects of class size on TD indicators and their determinants do not depend on student academic level.[3]

Class Size by STEM Designation

Progress on relevant objectives. The main effect for class size was significant, F (4, 489207) = 655.18, $p < .001$, partial η^2 = .01. Neither the interaction nor main effect for STEM met the criterion for meaningfulness. Students in small classes reported more progress than those in very large (d = .48) and >100 classes (d = .75); medium-size classes reported more progress than those with >100 enrollments (d = .51).

Dialogue. Multivariate main effects were significant for class size, Wilks' **Λ = .979**, F(12, 1294576.99) =848.60, $p < .001$, partial η^2 = .01; and STEM designation, Wilks' **Λ = 992**, F(3, 489304) = 1354.99, $p < .001$, partial η^2 = .01. Although the multivariate test for Class Size by STEM Designation was statistically significant, none of the univariate effects reached the criterion we set for meaningful differences.

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[3] In a separate analysis involving a different dataset, we also tested possible 2 x 5 Course Format (face-to-face, online) by Class Size interactions on the TD indicators. We found only one meaningful effect: Students in class sizes > 100 reported the instructor expected them to take greater share of the responsibility for learning than those in small classes (d = .57).

Univariate analyses revealed that for class size, main effects were significant for student desire to take the course ($p < .001$, partial η^2 = .01) and for how frequently the instructor fostered collaboration ($p < .001$, partial η^2 = .02) and established rapport ($p < .001$, partial η^2 = .01). Students in small classes reported a stronger desire to take the course than those in >100 size classes (d = .57); those in small classes also reported more collaboration than those in large (d = .58), very large (d = .80), and >100 (d = 1.21) classes; in addition, medium-size classes reported more collaboration than very large (d = .58) and >100 (d = .99) classes, as did large more so than >100 (d = .63). Students reported instructors did a better job of establishing rapport in small than large (d = .50), very large (d = .65), and >100 (d = .97) classes; and in medium than >100 size classes (d = .72).

Regarding the STEM main effect, the univariate analyses indicated the difference resided only in fostering collaboration ($p < .001$, partial η^2 = .01). Students in non-STEM courses reported their instructor fostered collaboration more frequently (d = .46).

Structure. The multivariate main effect was significant for class size, Wilks' **Λ = .99**, F(8,978610) =634.54, $p < .001$, partial η^2 = .01. Although the multivariate tests were also significant for the interaction term and the main effect of STEM designation, no univariate effects met the criterion for meaningful differences. With respect to the main effect of class size, mean student ratings were significantly different only for how frequently the instructor stimulated student interest ($p < .001$, partial η^2 = .01). Students in small classes gave higher ratings than those in large (d = .48), very large (d = .58), and >100 (d = .87) classes; in addition, ratings on stimulating student interest were higher in medium-size classes than >100 classes (d = .61).

Learner autonomy. As with structure, the multivariate test for class size was significant, Wilks' **Λ = .991**, *F* (12,1294576.99) = 356.29, $p < .001$, partial η^2 = .003. Again, though the tests were significant for the interaction term and STEM designation, no univariate tests reached the level of practical meaningfulness. For class size, main effects were significant for student effort in the course and instructor expectations that students take their share of responsibility for learning (both $p < .001$, partial $\boldsymbol{\eta}^2$ = .01). Students in small classes reported more effort than those in large (*d* = .50) and >100 size (*d* = .53) classes. In addition, students in small classes reported greater teacher expectations that students share responsibility for learning than those in large (*d* = .52), very large (*d* = .57) and >100 (*d* = .80) classes; those in medium classes also reported higher teacher expectations than students in >100 classes (*d* = .50).

Discussion

The effect of class size did not depend on student level or on whether the course was STEM or non-STEM. Differences were found by class size for student progress on relevant objectives and for all three indicators of TD. Students in small classes reported the most progress on relevant objectives, the strongest desire to take the course, and the most effort. They also reported more instructor attempts to foster student collaboration, establish rapport, and stimulate student interest than those in larger classes. Finally, in their view, the instructor expected them to take more of their share of responsibility for learning than that reported in larger classes. Several of these differences favoring small classes over classes with enrollments > 100 were strong effects based on Cohen's *d*: progress on relevant objectives, fostering collaboration, establishing rapport, stimulating interest, and expecting students to take share of responsibility for learning.

The effect of class size was also evident in medium compared to those with larger enrollments. Students in medium classes reported more teacher attempts at collaboration (a strong effect), establishing rapport, and stimulating student interest than those in larger classes; and they believed the instructor expected them to take a greater share of their responsibility for learning than those in >100 size classes. So, meaningful effects of at least one-half standard deviation in ratings were found in favor of class sizes ranging from 10 to 34 students. Even with large classes (enrollments of 35 to 49), more instructor attempts at fostering collaboration were reported than in classes with >100 students enrolled.

These findings have implications for the Theory of Transactional Distance. In small and medium classes students reported more teacher behaviors (collaboration and rapport) geared toward supporting dialogue both between students and the instructor and among classmates. When dialogue increases, TD should theoretically decrease. In addition, students reported they were more motivated to take the course. Motivation increases effort and energy (e.g., Maehr, 1984), attention (Pintrich & Schunk, 2002), and is strongly related to achievement (e.g., Gottfried, 1990; Schiefele, Krapp, & Winteler, 1992). It is not surprising, then, students in small and medium classes reported more progress on relevant objectives than those in classes with >100 students.

Class size was also related to the TD dimension of structure as it pertains to teacher behaviors that enhance motivation. Students in small and medium classes reported more teacher actions designed to stimulate student interest. When the classroom environment is more "situationally" interesting, students are more motivated and they learn more (e.g., Hidi, 1990).

Learner autonomy was another construct related to class size. Contrary to what we expected, however, students in small classes reported more effort than those in larger classes. In addition, those in small and medium classes reported greater teacher expectations that they share responsibility for learning. So learner behaviors that could have reduced transactional distance in large classes--if they were performed--were actually less likely to occur in larger classes.

In interpreting the current findings, we acknowledge several limitations. Our data were limited to classes that used the IDEA Student Ratings of Instruction. Moreover, we could not include other indicants of student learning (i.e., course exams, student projects) and teaching effectiveness (self-ratings, ratings by peers, alumni, etc.) because all student data were anonymous and no additional data were available from faculty. Fourth, the current findings are limited to the 12 learning objectives and 20 teaching methods contained in the IDEA system. Researchers should investigate other approaches to teaching not included in the IDEA instrument. Furthermore, qualitative approaches should be employed to reveal the unique approaches instructors take to apply teaching styles in classes of various sizes.

Overall, the current findings indicate class size is related to transactional distance. They say nothing, however, about the causal direction of that relationship. If given the choice, instructors who are comfortable with certain teaching styles might choose to teach smaller classes. Others who are more comfortable with lecturing might prefer large sections. Student who have good work habits and are motivated to learn might prefer to enroll in smaller classes. Students who are less motivated and studious may choose to enroll in larger sections.

Putting aside the question of causality, the current results are relevant to those who wish to explore the possibility of offering fewer sections with larger enrollments. The effects of class size on teacher behaviors and student learning, motivation, and work habits should be part of the conversation. Admittedly, learning analytics and data mining can potentially make

MOOCs and very large classes more personalized (Bienkowski, Feng, & Means, 2012). The instructor could have the ability to detect when a student is struggling and to provide targeted feedback and additional assignments to foster more dialogue, structure, and autonomy.

We recognize the cost of smaller classes in a higher education system that some view as already too expensive. Nonetheless policy makers and administrators cannot deny the self-reported learning benefits and positive attitudes toward smaller classes demonstrated in this study. Although our data are based on student self-report, we encourage others to examine direct measures of student outcomes. At the very least, understanding the qualities of small and medium classes that reduce transactional distance and support greater learning might improve the effectiveness of larger classes.

Appendix A: Teaching Method Subscale Styles on the IDEA Student Ratings Diagnostic Form

I. Stimulating Student Interest
4.Demonstrated the importance and significance of the subject matter
8. Stimulated students to intellectual effort beyond that required by most courses
13. Introduced stimulating ideas about the subject
15. Inspired students to set and achieve goals which really challenged them

II. Fostering Student Collaboration
5. Formed "teams" or "discussion groups" to facilitate learning
16. Asked students to share ideas and experiences with others whose backgrounds and viewpoints differ from their own
18. Asked students to help each other understand ideas or concepts

III. Establishing Rapport
1.Displayed a personal interest in students and their learning
2. Found ways to help students answer their own questions
7. Explained the reasons for criticisms of students' academic performance
20. Encourage student-faculty interactions outside of class (office visits, phone calls, e-mail, etc.)

IV. Encouraging Student Involvement
9. Encouraged students to use multiple resources (e.g. data banks, library holdings, outside experts) to improve understanding
11. Related course material to real life situations
14. Involved students' in "hands-on" projects such as research, case studies, or "real-life" activities
19. Gave projects, tests, or assignments that required original or creative thinking

V. Structuring Classroom Experience
3. Scheduled course work (class activities, test, and projects) in ways which encouraged students' to stay up-to-date in their work
6. Made it clear how each topic fit into the course
10. Explained course material clearly and concisely
12. Gave tests, projects, etc. that covered the most important points of the course
17. Provided timely and frequent feedback on tests, reports, projects, etc. to help students improve

Note. Derivative reproduction of table permitted by The IDEA Center.

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Table 2

Pearson r Correlations Between Dependent Measures

Variable	2	3	4	5	6	7	8	9
1. PRO	.40	.62	.82	.87	.82	.45	.39	.63
2. Desire to take course		.27	.30	.36	.28	.41	.34	.33
3. Foster collaboration			.73	.73	.61	.22	.32	.47
4. Establish rapport				.92	.88	.35	.33	.62
5. Stimulate interest					.88	.43	.36	.67
6. Structure classroom						.29	.25	.60
7. Effort							.47	.54
8. Typical work habits								.41
9. Teacher expectations								

Table 3

Descriptive Statistics for Measures of Dialogue by STEM Designation by Class Size

	USGOV STEM v non-STEM	Class Size	Mean	Std. Deviation	N
Really wanted to take course regardless of who taught it	nonSTEM	10-14	3.5627	.57191	57209
		15-34	3.3975	.53890	310741
		35-49	3.3293	.49107	43273
		50-100	3.3825	.53310	18443
		101+	3.2570	.45229	5062
		Total	3.4101	.54148	434728
	STEM	10-14	3.4511	.55357	6411
		15-34	3.2811	.53321	38565
		35-49	3.1809	.49797	5632
		50-100	3.2752	.49788	2962
		101+	3.1751	.47053	1018
		Total	3.2884	.53347	54588
	Total	10-14	3.5514	.57107	63620
		15-34	3.3846	.53951	349306
		35-49	3.3122	.49414	48905
		50-100	3.3677	.52965	21405
		101+	3.2433	.45638	6080
		Total	3.3966	.54195	489316
Foster_Collaboration	nonSTEM	10-14	4.0858	.61495	57209
		15-34	3.9436	.63206	310741
		35-49	3.6970	.68060	43273
		50-100	3.5498	.69269	18443
		101+	3.2574	.68246	5062

		Total	3.9131	.65349	434728
	STEM	10-14	3.7175	.70882	6411
		15-34	3.5519	.71092	38565
		35-49	3.3604	.68281	5632
		50-100	3.2652	.66648	2962
		101+	3.1223	.60884	1018
		Total	3.5280	.71379	54588
	Total	10-14	4.0487	.63480	63620
		15-34	3.9004	.65288	349306
		35-49	3.6582	.68928	48905
		50-100	3.5104	.69608	21405
		101+	3.2348	.67255	6080
		Total	3.8701	.67152	489316
Establish_Rapport	nonSTEM	10-14	4.3291	.45695	57209
		15-34	4.2116	.46502	310741
		35-49	4.0843	.47656	43273
		50-100	4.0134	.49213	18443
		101+	3.8510	.50128	5062
		Total	4.2018	.47367	434728
	STEM	10-14	4.2019	.48380	6411
		15-34	4.0997	.48792	38565
		35-49	4.0237	.48205	5632
		50-100	3.9585	.48963	2962
		101+	3.8723	.48434	1018
		Total	4.0920	.49074	54588
	Total	10-14	4.3163	.46131	63620
		15-34	4.1993	.46891	349306

	35-49	4.0773	.47759	48905
	50-100	4.0058	.49214	21405
	101+	3.8546	.49851	6080
	Total	4.1895	.47686	489316

Table 4

Descriptive Statistics for Measures of Structure by STEM Designation by Class Size

	USGOV STEM v non-STEM	Class Size	Mean	Std. Deviation	N
Stimulate_Interest	nonSTEM	10-14	4.3050	.47483	57209
		15-34	4.1795	.47828	310741
		35-49	4.0629	.48406	43273
		50-100	4.0139	.49544	18443
		101+	3.8604	.50642	5062
		Total	4.1737	.48543	434728
	STEM	10-14	4.1362	.51127	6411
		15-34	4.0088	.51970	38565
		35-49	3.9490	.50224	5632
		50-100	3.9420	.50191	2962
		101+	3.8547	.50110	1018
		Total	4.0111	.51848	54588
	Total	10-14	4.2880	.48131	63620
		15-34	4.1607	.48598	349306
		35-49	4.0498	.48754	48905
		50-100	4.0040	.49694	21405
		101+	3.8594	.50550	6080
		Total	4.1555	.49190	489316
Structure_Classroom_Exp	nonSTEM	10-14	4.3716	.45679	57209
		15-34	4.3058	.44861	310741
		35-49	4.2451	.44531	43273
		50-100	4.1814	.45936	18443

		101+	4.0722	.46433	5062
		Total	4.3004	.45245	434728
	STEM	10-14	4.2983	.47323	6411
		15-34	4.2592	.46228	38565
		35-49	4.2087	.45135	5632
		50-100	4.1647	.45663	2962
		101+	4.1155	.44053	1018
		Total	4.2508	.46309	54588
	Total	10-14	4.3642	.45900	63620
		15-34	4.3007	.45038	349306
		35-49	4.2409	.44616	48905
		50-100	4.1791	.45901	21405
		101+	4.0795	.46068	6080
		Total	4.2949	.45392	489316

Table 5

Descriptive Statistics for Measures of Learner Autonomy by STEM Designation by Class Size

	USGOV STEM v non-STEM	Class Size	Mean	Std. Deviation	N
I worked harder on this course than most courses I have taken	nonSTEM	10-14	3.8147	.55032	57209
		15-34	3.6507	.52226	310741
		35-49	3.5380	.51263	43273
		50-100	3.5789	.55686	18443
		101+	3.4649	.50679	5062
		Total	3.6559	.53153	434728
	STEM	10-14	3.7823	.53355	6411
		15-34	3.6596	.52526	38565
		35-49	3.6174	.51590	5632
		50-100	3.6852	.53883	2962
		101+	3.5406	.48156	1018
		Total	3.6688	.52729	54588
	Total	10-14	3.8115	.54874	63620
		15-34	3.6517	.52260	349306
		35-49	3.5471	.51363	48905
		50-100	3.5936	.55560	21405
		101+	3.4776	.50341	6080
		Total	3.6573	.53107	489316
As a rule, I put more effort than other students	nonSTEM	10-14	3.8745	.36747	57209
		15-34	3.8172	.32689	310741
		35-49	3.7846	.29037	43273
		50-100	3.8009	.27300	18443
		101+	3.7289	.23196	5062

		Total	3.8198	.32705	434728
	STEM	10-14	3.8202	.35989	6411
		15-34	3.7599	.32344	38565
		35-49	3.7625	.28780	5632
		50-100	3.7785	.26686	2962
		101+	3.7448	.24257	1018
		Total	3.7680	.32094	54588
	Total	10-14	3.8690	.36708	63620
		15-34	3.8109	.32700	349306
		35-49	3.7821	.29016	48905
		50-100	3.7978	.27226	21405
		101+	3.7315	.23382	6080
		Total	3.8140	.32678	489316
The instructor expected students to take their share of responsibility for learning	nonSTEM	10-14	4.4435	.34174	57209
		15-34	4.3457	.32318	310741
		35-49	4.2709	.29867	43273
		50-100	4.2522	.30000	18443
		101+	4.1799	.26676	5062
		Total	4.3452	.32567	434728
	STEM	10-14	4.3699	.33344	6411
		15-34	4.2868	.31909	38565
		35-49	4.2473	.29534	5632
		50-100	4.2496	.28564	2962
		101+	4.1605	.25890	1018
		Total	4.2881	.31781	54588
	Total	10-14	4.4361	.34163	63620
		15-34	4.3392	.32326	349306

	35-49	4.2682	.29838	48905
	50-100	4.2518	.29805	21405
	101+	4.1766	.26554	6080
	Total	4.3388	.32529	489316