It’s about time: The relationships between coverage and instructional practices in college calculus

We draw on a large-scale empirical study designed to investigate Calculus I programs across the United States to better understand the relationship between instructors’ concerns about coverage, instructional practices, and the nature of the material covered. We found that there was no association between instructors feeling pressured to go through material quickly to cover all the required topics and intended pacing. Furthermore, our results suggest that both intended pacing and feelings of pressure are poor indicators of instructional practices.

Keywords: calculus, coverage, teaching practices, pacing

Subject classification codes: 97

1: Introduction

Undergraduate students in the United States (US) cite poor instruction in their introductory mathematics and science courses as a contributing reason for why they discontinue in science, technology, engineering, and mathematics (STEM) fields. [1,2] One of the most influential studies that examined why US students leave STEM majors is the work by Seymour and Hewitt. [1] A primary finding from this work is that students typically do not leave STEM majors for academic or financial reasons; rather, students are leaving STEM majors as a result of poor mathematics and science instruction – most specifically, poor calculus instruction is often cited as the primary reason. Some specific problems that students identify include: courses that are oversaturated with material, pacing that inhibits comprehension and reflection, the lack of applications or conceptual discussions, and teaching practices that suggest instructors take little responsibility for student success. [3]

While courses that are over-burdened with material and taught in an uninspiring and unresponsive manner have been found to drive away STEM-intending students, researchers are amassing a strong and growing body of research on the positive benefits of more student-centred instructional approaches. Such instructional practices include having students work together, holding whole class discussions, and asking students to explain their thinking. In practice, student-centred instruction has been shown to support conceptual learning gains [4-6], diminish the achievement gap between female and male students [6], and improve STEM retention rates [7, 8, 1]. Specifically regarding Calculus I, Rasmussen and Ellis [9] found that students were most likely to continue on to Calculus II if their Calculus I instructors exhibited both "progressive teaching" traits (e.g., asking students to explain their thinking on homework and exams, requiring students to work together, having students give presentations, etc.) and "good teaching" traits (e.g., listening carefully to students' questions and comments, allowing time for students to understand difficult ideas, presenting more than one method for solving problems, etc.) [p. 6].

Despite the benefits of student-centred instruction touted by the research, lecture is still the overwhelmingly predominant instructional technique in US Calculus I courses [10]. A common reason cited for the prevalence of lecture is the idea that pressure to cover a set amount of material precludes efforts to adopt student-centred pedagogy. Indeed students are not the only ones reporting that there is not enough time in class for understanding difficult ideas. In a recent study of Calculus I instruction, Johnson and Ellis [11] found that 20% of students believed that there was not enough time in class to understand difficult ideas and 26% of students were instructed by teachers that believed that there was not enough time to understand difficult ideas.

The perception that there is not enough time to understand difficult ideas is often cited by instructors as a reason for not engaging in more student-centred pedagogy [12-16] (which as we saw earlier, contributes to students deciding not to continue on to Calculus II; consequently driving students away from STEM majors). For instance, in a case study of two mathematicians attempting to implement reform curriculum in mathematics courses for preservice teachers, McDuffie and Graeber [13] identified a number of institutional norms and policies that curtailed their efforts. As stated by one of the mathematicians:

> If you've got courses that link together, as most of the math curriculum does…there's an expectation that a certain amount of material be covered…It means that you're limited on how much time you can spend to do real constructivist activities where the depth of knowledge is really greater. [13, p.336]

Concerns about coverage are pervasive, with many mathematicians feeling pressure to "get through" all the material. As Yoshinobu and Jones [17] explained, calculus courses are often packed full of content, with typical textbooks containing hundreds, or even thousands, of pages of material. As a result, instructors feel pressure to cover material quickly, which then heavily influences teaching practices. Yoshinobu and Jones argued that, "the (perceived) need to cover all the topics encourages the use of the standard model" [17, p.303], where the standard model is a teacher-centred lecture method of teaching. They went on to state, "the pressure to cover everything makes it difficult to use another teaching model" [p.304].

Taken as a whole, the reports from students and instructors suggest that calculus courses are overburdened with content, and in order to cover such large amounts of material instructors cannot implement student-centred instructional practices. In this study, we investigate the validity of such claims using data collected at 197 research universities across the United States, including five institutions that were selected for having particularly successful Calculus I programs. Specifically, we investigate the following question: what is the relationship between coverage concerns, instructional practices, and the amount of material expected to be covered at PhD-granting universities?

2: Research setting and data

This study is situated within a larger project, Characteristics of Successful Programs in College Calculus (CSPCC)[1]. The CSPCC project is a large, two-phase empirical study designed to investigate Calculus I programs across the United States. The first phase of this study was a large-scale survey of Calculus I instruction that was conducted across a stratified random sample of two- and four-year undergraduate colleges and universities. In 2010, students and instructors from these institutions were sent surveys at both the beginning and the end of Calculus I. These surveys were designed to gain an overview of the various calculus programs nationwide and to determine the relative success of the programs on an institutional level. Survey design was informed by a thorough literature review on instructional, institutional, and individual factors that contribute to student success. For more information regarding the survey itself, specifically the results concerning the demographics of US Calculus students and the measures of student success, see Bressoud, Carlson, Mesa, and Rasmussen [18].

In the CSPCC project, successful Calculus I programs were defined by a combination of student variables. The first variable, affective outcomes, corresponded to positive changes in student reports of confidence, desire to continue studying mathematics, enjoyment, interest, and intention to take Calculus II. These changes were calculated by comparing the responses on the students' end-of-term survey to those on the beginning-of-term survey. The second variable, persistence outcomes, focused on two questions from the student surveys: intention to take calculus II at the beginning of the term (Yes/No) and intention to take calculus II at the end of the term (Yes/No). We used this variable to identify schools with a "switcher" percentage lower than the national average (where "switchers" are students who intended to take Calculus II at the beginning of the semester, but then decided not to by the

[1] For more information on the study, see www.maa.org/CSPCC

end of the semester). The last variable, achievement outcomes, compared the expected pass rate at each institution (as estimated by a statistical model based on the institutions' average SAT scores and six-year graduation rate) and the actual pass rate (as reported on the end-of-term instructor survey). Additionally, all selected schools had a high response rate on all surveys. One additional school was selected because it had very high response rates, and although it did not rise to the top of the statistical comparisons described above, it had been previously recognized for innovative practices in calculus. (For more detailed account of this analysis see Hsu, Mesa, and the Calculus Case Collective [19].)

Surveys were analysed in order to select four to five institutions of each type (AS-granting 2-year colleges, BA-granting 4-year colleges, MA-granting universities, and PhD-granting universities - as determined by the highest degree offered in mathematics) that demonstrated a greater measure of success compared to their counterpart institutions. In the second phase of this project, the CSPCC team then conducted three-day site visits at each of the 18 selected institutions. Site visits included interviews with students, instructors, and administrators; classroom observations; and the collection of exams, course materials, and homework.

For this report, we narrow our focus to PhD-granting universities and consider two populations of instructors: those at institutions that were selected based on the success of their calculus programs and those at institutions that were not selected. We chose to focus on PhD-granting institutions for a number of reasons. First, of the 234,000 students taking mainstream Calculus I in the United States in 2010, nearly half of them (110,000) did so at PhD-granting universities. [20] By focusing on this institution type, we are able to report on the instructors with the greatest audience. Second, PhD-granting institutions have greater variance in terms of section size as compared with the other institution types in our sample. This variability (ranging from 30 students per section to upwards of 200 students) is especially helpful in a study examining instructional methods because it affords us the opportunity to examine instructor concerns and practices in a wide variety of classroom settings (e.g. small class, recitation, large lecture, etc.). Finally, at each of the selected PhD-granting universities, there was a high level of coordination among the different sections. The use of common syllabi, common textbooks and section coverage, common exams, and common homework assignments allows us to report on department- level intended pacing at the selected universities.

2.1: selected universities

Based on survey responses from Phase 1 of the CSPCC project, the following five PhD-granting universities were selected for in-depth case studies: Large Private University (LPrU), Public Technical University (PTU), Large Public University 1 (LPU1), Large Public University 2 (LPU2), Private Technical Institute (PrTI). Table 1 provides a brief overview of these institutions.

[Insert Table 1 here]

2.2: data analysis and descriptive statistics

In order to investigate the relationship between coverage expectations, coverage concerns, and instructional practices, we draw on a variety of data to first understand how each of these factors individually varies across selected and non-selected institutions. Instructor survey responses were solicited from both selected and non-selected institutions resulting in a survey response of 208 instructors (at PhD-granting institutions) who answered at least some of the questions, 50 of whom came from a selected institution. In addition to the survey data, syllabi and departmental course lists of required sections were collected from each of the selected institutions during the site visits. Here we provide descriptive statistics for the three parameters of interest: instructor concerns about coverage, instructional practices, and the material expected to be covered. Relationships between these parameters are the focus of our research question and are discussed in the results section.

2.2.1: instructor concerns about coverage

As part of the survey, instructors were asked to respond to the following prompt: "When teaching Calculus I, I felt pressured to go through material quickly to cover all the required topics." This question was asked on a Likert scale from 1 to 6, with 1 meaning "not at all" and 6 meaning "very often". Instructor responses were binned into the following categories: Low (response of 1 or 2), Medium (response of 3 or 4), or High (response of 5 or 6). As shown in Table 2, concerns about coverage did not differ significantly among instructors at selected and non-selected institutions. Approximately 20% of instructors (19.6% and 19.5% from selected and non-selected respectively) reported feeling high amounts of pressure to cover material quickly.

[Insert Table 2 here]

2.2.2: instructional practices

To capture data concerning instructional practices, the instructors were asked to report, on a scale from 1 (not at all) to 6 (very often), the frequency in which they engaged in eight specific instructional activities:

1. Show students how to work specific problems
2. Have students work with one another
3. Hold a whole-class discussion
4. Have students give presentations
5. Have students work individually on problems or tasks
6. Lecture
7. Ask questions
8. Ask students to explain their thinking

As before, the responses were consolidated into the following categories: Low (response of 1 or 2), Medium (response of 3 or 4), or High (response of 5 or 6). These results, aggregated by practice and nature of institution, can be seen in Table 3.

[Insert Table 3 here]

As shown in Table 3, the majority of instructors from non-selected institutions reported high frequencies of: showing students how to work specific problems, lecturing, and asking questions. In comparison, the majority of instructors from selected institutions reported high frequencies of: showing students how to work specific problems, having students work with one another, lecturing, asking questions, and asking students to explain their thinking. These reports suggest a pattern of qualitatively different instruction at selected and non-selected institutions.

To determine if these reports were statistically significant, a Kruskal-Wallis one-way analysis of variance by ranks was conducted for each of the eight instructional practices. We found statistically significant differences between instructors from selected and non-selected institutions in regards to four instructional practices. As compared with teachers at non-selected institutions, teachers at selected institutions reported:

- Having students work together more frequently [$p < .001$]
- Having students engage in whole-class discussion more frequently [$p = .006$]
- Having students give presentations more frequently [$p = .001$]
- Having students explain their thinking more frequently [$p = .017$]

It should be noted, however, that 28 out of the 47 instructors from the selected universities were from the same institution - LPU1. As we will see in later results, the instructors from LPU1, the vast majority of whom were graduate students, reported very similar teaching practices. Therefore, some of these statistically significant differences may be explained by the practices at LPU1. In particular, 26 of the LPU1 instructors reported high frequency of having students work together and 21 reported high frequency of asking students to explain their thinking - practices that were heavily emphasized in their graduate student teaching professional development training. [21] A more in-depth analysis of the instructors at selected universities is discussed in the results section.

2.2.3: the amount of material expected to be covered

The amount of material expected to be covered was determined using course syllabi and departmental course lists of required sections. Each of the five selected institutions had a fairly uniform Calculus I program, which included a common textbook and a common list of required sections to be covered. Four of the five departments provided a list of required textbook sections. The fifth department, PrTI, provided a required list of textbook chapters. A master list of section titles was compiled and equivalent section titles were then grouped together to better reflect commonalities between the topics. For instance, the sections entitled *The Derivative as a Rate of Change, Rates of Change,* and *The Derivate and Rates of Change* were condensed into one heading. Section titles were not condensed in instances when it would change the number of sections or when it was unclear if the sections included the same material.

Analysis of the common syllabi identified six areas that were included in at least one of the Calculus I programs: Function Review, Limits, Derivatives, Differentiation Rules, Differentiation Applications, and Integrals. Only two of the schools, LPU1 and LPU2, covered sections in all six areas. For each of the five institutions, Table 4 shows the number of sections in each area that was included in their Calculus I course as well as their pace (number of sections per week).

[Insert Table 4 here]

3: Results and discussion

Here we present our analyses of the relationships between instructor concerns about coverage, reported instructional practices, and intended pacing. We begin by looking at possible relationships between concerns about coverage and instructional practices. Our analysis was done with data from both selected and non-selected universities. We then take a more in-depth look at instructors at selected institutions to explore how intended pacing rates may relate to instructional practices and concerns about.

3.1: relationship between concerns about coverage and instructional practices

As previously discussed, a common reason cited for not implementing student-centred instructional practices is a concern about coverage expectations. For this reason, we decided to contrast the instructional practices of instructors that reported High feelings of pressure to cover material with those instructors that reported Medium or Low feelings of coverage pressure.

As can be seen in Table 5, the majority (60%) of instructors from non-selected institutions report holding whole class discussions with low frequency and an overwhelming majority (85%) report lecturing with high frequency – regardless of the reported amount of pressure they were feeling to cover material quickly.

In fact, at non-selected institutions most of the instructional practices appear to be stable regardless of how much pressure instructors were feeling to get through the material; the lone exception being the frequency with which instructors reported having students give presentations. At the non-selected institutions 100% of instructors who reported high pressure had students present at low frequency, while among instructors who reported low or medium pressure 84% had students present at low frequency. However, it should be noted that only

1.9% of instructors reported high frequency of student presentations, so this is not a widely reported teaching practice in either case.

[Insert Table 5 here]

Table 6 shows the comparison between instructors that felt high pressure and those that felt either medium or low pressure at selected institutions. As we saw with instructors from non-selected institutions, we see relative stability for most instructional practices among instructors from selected institutions. That being said, there are two practices that we would like to call attention: lecturing and having students work with one another. The majority of instructors reporting low/medium feelings of pressure had their students work with one another with high frequency; whereas, the majority of instructors reporting high feelings of pressure had their students work with one another with low frequency. Additionally, all of the instructors at the selected institutions that felt high pressure also lectured with high frequency, compared to only 65% of the instructors with low/medium pressure.

The other instructional practices are less associated with feelings of pressure to cover material. Most of the instructors at selected institutions, regardless of how much pressure they felt to cover material quickly, reported the following:

- showing students how to work specific problems with medium/high frequency
- holding whole class discussion with low/medium frequency
- having students give presentation with low frequency
- having students work individually with medium/high frequency
- asking questions with high frequency
- asking students to explain their thinking with medium/high frequency

[Insert Table 6 here]

To further investigate relationships between instructional practices and coverage concerns, we analysed correlations between reports of pressure and reports of instruction for all instructors involved in the study. Based on the Spearman's rho statistic[2], we determined that of the eight instructional practices under investigation, only one – showing students how to solve specific problems – was significantly correlated with concerns over coverage ($r = -.142$; $p = .043$, $n = 204$). This indicates no relationship between concerns over coverage and instructional practices, except in regards to how often they show students how to work specific problems. One interpretation of this is that when instructors are feeling more pressure to cover material, instead of showing students how to work more additional problems during class they offload practice problems to homework or office hours.

We found similar results when only considering instructors from non-selected schools. The only statistically significant correlation was a negative correlation between concerns over coverage and showing students how to work specific problems [$r_s = -.191$, $p = .016$, $n = 158$]. The only significant correlation among instructors from selected universities was a positive relationship between concerns over coverage and lecture [$r_s = .325$ $p = .027$, $n = 46$]. This finding indicates that even when instructors include more lecture, they did not do so by eliminating other instructional practices. Instead, these findings suggest that instructors at selected institutions pair student-centred practices *with* lecture when they are pressured for time. This is an important distinction to make because, when paired with other activities that engage students, lecture can be a highly productive instructional practice.

Overall our findings indicate that instructors at selected institutions engage their students in more student-centred pedagogy than their counterparts at non-selected institutions, and when they felt time pressure they added lecture to these practices. Therefore,

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[2] Kendall's tau coefficient was also investigated and produced similar results.

at the selected institutions there was some evidence to support the claim that instructors lecture more when they feel pressure to cover material quickly. While this relationship between pressure to cover material and increased lecture is discussed in the literature (e.g., [5]) this association was not present for instructors at non-selected institutions.

3.2: relationship between concerns about coverage and intended pacing

In this section, we investigate the degree to which instructors' concerns about coverage were related to their intended pacing rates, as determined by course syllabi. We are only able to investigate this relationship among the instructors at the five selected institutions since we only have the syllabi from the selected institutions. Table 7 shows the intended pacing (sections covered per week as per the syllabus) and the number of instructors from each institution that reported a "high" response to the prompt "When teaching Calculus I, I felt pressured to go through material quickly to cover all the required topics".

[Insert Table 7 here]

Looking across the five selected institutions, we see no association between the rate at which instructors were expected to cover material and reported feelings of pressure to go through material quickly in order to cover the required topics. This lack of association is exemplified when considering the two schools with the largest difference in the number of sections covered per week. Instructors at LPrU were expected to cover 23 sections over the course of a 15-week term (1.53 topics per week) and instructors at PTI were expected to cover 28 sections over the course of a 7-week term (4 topics per week). Notice that instructors from PTI, the institution with the most material covered per week, were less likely to report high concerns about coverage than instructors from LPrU, who had more time to cover less material.

While pacing alone does not appear to account for coverage pressure, it should be noted that there were differences in the required topics for these two institutions. Most notably, the common syllabus at PTI included five sections on function review and zero sections on integrals (out of 28 total sections) while the common syllabus for LPrU included zero sections on function review and six sections on integrals (out of a total 23 sections). Of the five universities, LPrU was the only one without function review included on the required list of topics and the only one where the majority of instructors reported strong concerns about coverage. At the same time, however, the three institutions with the most sections on integrals did not exhibit any sort of commonality in regards to concerns about coverage. PTI included eight sections on integrals while none of the six instructors reported "high" concerns where as both LPrU and LPU2 had six sections on integrals with two out of three and one out of four reports of "high" concerns (respectively). At the very least, this finding suggests that instructors' concerns about coverage may be more impacted by *what* material is included in a course than by *how much* material is included in a course, with function review standing out as potentially significant.

3.3: relationship between instructional practices and intended pacing

To understand the relationship between instructional practices and intended pacing rates, we draw on the syllabi analyses (available only at selected institutions) and instructors' reported instructional practices. In Table 8 we present the number of instructors at each institution that reported either a "low" or a "high" frequency for each of the eight instructional practices.

[Insert Table 8 here]

Table 8 illustrates a lack of association between intended pacing and instructional practices. For instance, consider the university with the slowest pacing LPrU (1.53 sections per week), and the university with the fastest pacing, PTI (4 sections per week). At both of these institutions we see that the majority of instructors only engaged with a handful of instructional practices at high frequency. At LPrU the majority of instructors engaged in 4 practices with high frequency, while at PTI the majority of instructors engaged in 3 practices with high frequency. Furthermore, there is a strong overlap between the practices at these two universities, with these practices representing a more teacher-centred model of instruction (e.g., lecturing, showing students how to work specific problems). That both the university with the slowest pacing and the university with the highest pacing reported such similar teaching practices is illustrative of the lack of association we found between intended pacing and instructional practices among the selected institutions.

Further illustrating the lack of association, consider LPU1 (2.20 sections per week) and PTU (2.07 sections per week). In addition to having a similar pacing rate, instructors from these two institutions use the same text [22]; however, the instructors are quite different pedagogically. At LPU1 we see that the majority of instructors engaged in five instructional practices at high frequency and engaged in all eight instructional practices with at least medium frequency. This is contrasted with instructors from PTU who only reported showing students how to work specific problems, lecturing, and asking student questions with high frequency. Therefore, our analysis suggests that at selected institutions there is no association between instructional practices and intended pacing.

4: Conclusions

Our results indicate that both intended pacing and feelings of pressure are actually poor indicators of instructional practices. In fact, the common adage that high coverage demands encourage (or even necessitate) more teacher-centred instructional practices is not supported by our analysis. Additionally, among instructors at the five selected institutions, we found that there was no association between intended pacing and feeling pressured to go through material quickly to cover all the required topics. While a lack of evidence should not be taken as conclusive evidence that there is no relationship, we can conclusively state that in a study of 204 Calculus I instructors at PhD-granting universities we found no significant statistical association between feeling pressure to cover material and the reported frequency of engaging in seven of the eight instructional practices (with showing students how to work specific problems bearing the only statistically significant association). Additionally, among the 46 instructors for whom we were able to calculate an intended pacing rate, some factor other than the amount of material they needed to cover was attributing to a feeling of pressure to go through the material quickly.

Finding no significant relationships between coverage concerns or intended pacing rates and instructional practices allows us to push the conversation past a rather simplistic position that pedagogical decisions are explained by a single factor – the amount of material one is expected to teach. Pedagogical decisions are made for a variety of reasons that take into account both individual and departmental considerations. For instance, while we did not find any association between intended pacing or feelings of pressure and instructional practices, other factors such as class size and instructor rank did appear to be related to instructional practices.

Across all PhD-granting universities in our data set, we found a statistically significant correlation between class size and six of the instructional practices. Specifically, the smaller the class size the *more* frequently instructors reported: having their students work together [$r_s = -.347$, $p < .001$, $n = 204$], holding whole class discussion [$r_s = -.238$, $p = .001$, $n = 202$], having students give presentations [$r_s = -.352$, $p < .001$, $n = 202$], asking students questions [$r_s = -.178$, $p = .011$, $n = 204$], and asking students to explain their thinking [$r_s = -.282$, $p < .001$, $n = 202$]; while the smaller the class size the *less* frequently instructors reported lecturing [$r_s = .250$, $p < .001$, $n = 204$]. Furthermore, when comparing ladder rank instructors (e.g. tenure track and tenured faculty) and non-tenure track instructors (e.g., graduate teaching assistants and adjuncts), ladder rank instructors: have students work together less frequently ($p < .001$), have students give presentations less frequently ($p < .001$), have students work individually less frequently ($p = .001$), and ask students to explain their thinking less frequently ($p = .008$). Interestingly, no association was found between either class size or instructor rank and concerns about coverage. Together these results indicate that, rather than simply citing coverage concerns as justification for choice of instructional practice, non-coverage related factors warrant more attention and consideration in conversations regarding instructional decisions at the undergraduate level.

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Table 1. Summary of selected institutions.

Institution Pseudonym	Instructors with survey responses	Term length (weeks)	Calculus I class size	Text Used
Large Private University (LPrU)	3	15	40-300	*Single Variable Calculus: Early Transcendentals* by Stewart
Public Technical University (PTU)	7	14	35-45	*Calculus, Single and Multivariable (Fifth Edition)* by Hughes-Hallett, et al.
Large Public University 1 (LPU1)	30	15	30-35	*Calculus, Single and Multivariable (Fifth Edition)* by Hughes-Hallett, et al.
Large Public University 2 (LPU2)	4	11	200-250	*Calculus: Early Transcendentals* by Jon Rogawski
Private Technical Institute (PrTI)	6	7	30-35	*Calculus: Early Transcendentals (7^{th} edition)* by Edwards and Penny

Table 2. Concerns about coverage at non-selected and selected institutions.

	Low	Med	High
When teaching Calculus I, I felt pressured to go through material quickly to cover all the required topics			
Non-selected (n=159)	44.7%	35.7%	19.5%
Selected (n=46)	30.4%	50%	19.6%

Table 3. Instructional practices at non-selected and selected institutions.

During class time, how frequently did you:	**Low**	**Med**	**High**
show students how to work specific problems?			
Non-selected (n=162)	3.7%	21%	75.3%
Selected (n=47)	0%	21.3%	78.7%
have students work with one another?			
Non-selected (n=162)	59.3%	23.5%	17.3%
Selected (n=47)	27.7%	10.6%	61.7%
hold a whole-class discussion?			
Non-selected (n=160)	56.3%	26.9%	16.9%
Selected (n=47)	40.4%	29.8%	29.8%
have students give presentations?			
Non-selected (n=161)	88.8%	9.3%	1.9%
Selected (n=46)	65.2%	17.4%	17.4%
have students work individually on problems or tasks?			
Non-selected (n=161)	54.7%	26.1%	19.3%
Selected (n=47)	36.2%	38.3%	25.5%
lecture?			
Non-selected (n=162)	4.3%	11.7%	84.0%
Selected (n=47)	4.3%	25.5%	70.2%
ask questions?			
Non-selected (n=162)	3.7%	19.8%	76.5%
Selected (n=47)	2.1%	17.0%	80.9%
ask students to explain their thinking?			
Non-selected (n=160)	26.9%	36.3%	36.9%
Selected (n=47)	14.9%	29.8%	55.3%

Table 4. Nature and pacing of material at selected institutions.

Topic covered	**Institution**				
	LPrU	**PTU**	**LPU1**	**LPU2**	**PrTI**
Function Review	0	6	6	3	5
Limits	4	0	2	8	4
Derivatives	2	4	6	3	1
Differentiation rules	4	7	7	7	5
Differentiation Applications	7	4	7	8	13
Integrals	6	8	5	6	0
Total	***23***	***29***	***33***	***35***	***28***
Pacing (Topics per weeks in term)	**1.53**	**2.07**	**2.20**	**3.18**	**4.00**

Table 5. Instructional practices among instructors at non-selected institutions who reported high amount of pressure compared to those who reported low/medium amounts of pressure.

During class time, how frequently did you:	**Low**	**Med**	**High**
show students how to work specific problems?			
Low/ Med Pressure (n=127)	2.4%	22.0%	75.6%
High Pressure (n=31)	9.7%	19.4%	71.0%
have students work with one another?			
Low/ Med Pressure (n=127)	55.9%	26.8%	17.3%
High Pressure (n=31)	74.2%	12.9%	12.9%
hold a whole-class discussion?			
Low/ Med Pressure (n=125)	56.8%	28.8%	14.4%
High Pressure (n=31)	61.3%	22.6%	16.1%
have students give presentations?			
Low/ Med Pressure (n=126)	85.7%	11.9%	2.4%
High Pressure (n=31)	100.0%	0.0%	0.0%
have students work individually on problems or tasks?			
Low/ Med Pressure (n=126)	53.2%	27.8%	19.0%
High Pressure (n=31)	61.3%	19.4%	19.4%
lecture?			
Low/ Med Pressure (n=127)	3.9%	11.0%	85.0%
High Pressure (n=31)	3.2%	12.9%	83.9%
ask questions?			
Low/ Med Pressure (n=127)	3.9%	18.9%	77.2%
High Pressure (n=31)	3.2%	22.6%	74.2%
ask students to explain their thinking?			
Low/ Med Pressure (n=125)	24.0%	36.8%	39.2%
High Pressure (n=31)	35.5%	38.7%	25.8%

Table 6. Instructional practices among instructors at selected institutions who reported high amount of pressure compared to those who reported low/medium amounts of pressure.

During class time, how frequently did you:	**Low**	**Med**	**High**
show students how to work specific problems?			
Low/ Med Pressure (n=37)	0%	27%	73%
High Pressure (n=9)	0%	0%	100%
have students work with one another?			
Low/ Med Pressure (n=37)	21.6%	10.8%	67.6%
High Pressure (n=9)	55.6%	11.1%	33.3%
hold a whole-class discussion?			
Low/ Med Pressure (n=37)	35.1%	35.1%	29.7%
High Pressure (n=9)	55.6%	11.1%	33.3%
have students give presentations?			
Low/ Med Pressure (n=36)	66.7%	22.2%	11.1%
High Pressure (n=9)	66.7%	0.0%	33.3%
have students work individually on problems or tasks?			
Low/ Med Pressure (n=37)	37.8%	40.5%	21.6%
High Pressure (n=9)	33.3%	22.2%	44.4%
lecture?			
Low/ Med Pressure (n=37)	5.4%	29.7%	64.9%
High Pressure (n=9)	0%	0%	100%
ask questions?			
Low/ Med Pressure (n=37)	0.0%	18.9%	81.1%
High Pressure (n=9)	11.1%	11.1%	77.8%
ask students to explain their thinking?			
Low/ Med Pressure (n=37)	10.8%	32.4%	56.8%
High Pressure (n=9)	33.3%	22.2%	44.4%

Table 7. Intended pacing rates and concerns about coverage at selected institutions.

	LPrU (n=3)	**PTU (n=6)**	**LPU1 (n=27)**	**LPU2 (n=4)**	**PTI (n=6)**
Intended Pacing (Sections per Week)	1.53	2.07	2.20	3.18	4.00
Fraction of instructors reporting high pressure	2/3	0/6	4/27	1/4	2/6

Table 8. Intended pacing and instructional practices at selected institutions.

	LPrU (1.53 Sections per Week)		**PTU (2.07 Sections Per Week)**		**LPU1 (2.20 Sections Per Week)**		**LPU2 (3.18 Sections Per Week)**		**PTI (4.00 Sections Per Week)**	
During class time, how frequently did you: (1=not at all; 6=very often)	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**	**Low**	**High**
show students how to work specific problems?	0	3	0	5	9	19	0	4	0	6
have students work with one another?	2	1	2	1	0	26	4	0	5	1
hold a whole-class discussion?	2	1	3	1	8	10	1	2	5	0
have students give presentations?	3	0	5	0	13	8	4	0	5	0
have students work individually on problems or tasks?	1	2	0	2	13	7	0	0	3	1
lecture?	0	3	1	4	1	17	0	4	0	5
ask questions?	1	2	0	5	0	22	0	4	0	5
ask students to explain their thinking?	2	1	1	1	2	21	1	2	1	1
Total Number of Instructors per University	***3***		***6***		***28***		***4***		***6***	