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Online lecture accessibility and its influence on performance in skills-based courses

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ABSTRACT

At the University of Toronto at Scarborough, we provide enhanced flexibility to our students using a blended-learning approach (i.e., the webOption) whereby students can attend lectures live, watch them online at their convenience, or both. The current research examines the use of pause and seeks features afforded by the webOption interface and how these features are related to students' learning approaches and their performance in calculus courses. These courses emphasize the teaching of mathematical proofs; cognitive skills that are enhanced with practice (Schneider & Shiffrin, 1977). Access to online lectures allows students to re-experience the professor as they teach these skills. Given this, it was predicted that use of the webOption might be especially potent in these learning contexts. The results we report here do not confirm that prediction. Students do use and appreciate the features of the webOption, however, those students who augmented their class attendance with online viewing, and those who used the lecture-control features the most, were actually the students who performed most poorly. We interpreted the results to be due to different learning strategies and the manner in which these strategies interact with course content. Our results suggest that using the pause feature is related to a surface strategy of learning, which is in turn related to poorer performance in the course.

1. Introduction

The use of online technology for education is becoming more and more popular in higher education institutions (e.g., Brinkman, Rae, & Dwivedi, 2007; Ellis, Ginns, & Piggott, 2009; Ellis, Goodyear, O'Hara, & Prosser, 2007; Ginns & Ellis, 2007; Haapala, 2006; Hay, Peltier, & Drago, 2004; MacKenzie & Walsh, 2009; McNaught & Lam, 2005; Woo et al., 2008). At the University of Toronto Scarborough, we provide enhanced flexibility to our students using a blended-learning approach that we refer to as the webOption. This approach entails videotaping classes as they are offered in a traditional manner, and then posting the videos online for subsequent student access. Thus, students have the option of attending lectures live, watching them online after the lecture, or both.

We have offered webOptioned courses at the University of Toronto Scarborough for over 6 years, and have conducted research examining student satisfaction and performance since webOption's first implementation (e.g., Bassili & Joordens, 2008). The goal of webOption is to augment traditional lectures by providing students with flexibility. Lectures are presented as they normally would with the addition that the lectures are taped by a videographer who attempts to capture the classroom experience to the best of their ability. The resulting videos are the posted on the web, typically on the same day as the live lecture.

Our initial research was conducted in the context of our Introductory Psychology courses, which focus primarily on teaching students the theories, definitions, experiments and perspectives that form the field. For contrast, we will frame this sort of course as one the focuses on the communication of concepts rather than cognitive skills. It is clearly the case that most courses involve the communication of both concepts and skills, and we do not mean to imply that any course focuses exclusively on one or the other. But relative to the mathematics courses that will provide the context for the current work, it is fair to say that Introductory Psychology involves less emphasis on learning procedural skills of the sort needed to solve mathematical problems.

The findings from our previous research (Bassili & Joordens, 2008) showed that students were satisfied by our implementation, a result bolstered by their loudly voiced desire to have more courses provided in this manner. Students also made extensive use of the pause and seek functions provided by the media player, essentially taking control of the rate of information presentation. Most intriguing, usage of

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these features was positively correlated with exam performance such that those who used these features more scored higher on a high-stakes exam.

Subsequent research on the webOption has been primarily concerned with what underlies student decisions to attend lectures or watch them online. For example, Bassili (2008a) showed that attitudes concerning whether students liked the option of having online lectures were predicted by motivational orientations, whereas the actual choice to attend lectures or watch them online was related to students' cognitive strategies. In addition, Bassili (2008b) showed that students' perceptions of media richness also predicted their tendencies to attend class or watch online, and that students were especially likely to attend classes when they perceived the content to be difficult.

However, the current work is most related to the original work by Bassili and Joordens (2008), assessing whether the performance advantage they documented might be especially potent in the context of mathematics. As mentioned previously, a correlation between use of the media-player features and performance on a high-stakes exam was observed in the context of Introductory Psychology, but those correlations were modest with Pearson r values in the 0.10–0.13 range. It seemed entirely plausible that the ability to pause or seek lectures, while clearly useful in the context of Introductory Psychology, might be even more valuable in the context of mathematics courses.

Mathematics courses, and especially the calculus courses we examine here, are notoriously difficult for many students (see Doorman & van Maanen, 2008; Pettersson & Scheja, 2008). This difficulty stems from several sources. First, students must keep up with the material as work tends to build incrementally. Having access to previous lectures should allow students to never miss a lecture, and to return to lectures they saw but perhaps forgot or never really understood. Second, the classes have a much larger emphasis on the deep learning of specific cognitive skills (Biggs, Kember, & Leung, 2001), the skills relevant to mathematics proofs. Typically these skills are demonstrated in-class and then practiced by the students outside of class. If a student forgets some step between the presentation and the practice, they could encounter real problems. Having access to the lectures allows students to virtually return to the classroom and watch the demonstration again, perhaps with their homework problems in hand. These two issues alone suggest that the webOption approach might be especially beneficial to students in the context of challenging mathematics. Thus, the purpose of Experiment 1 was to assess the impact of implementing the webOption in the context of two courses; Calculus I (MATA30) and Calculus for Management I (MATA32). By performing the same study in two different classes we were also able to assess the reliability of the results.

As we will see, the results from Experiment 1 did not confirm our prediction. We found those students who augmented their class attendance with online viewing, and those who used the pause and seek features the most, were the students who performed most poorly in the calculus courses. Thus, students who had the most trouble with the course did use the webOption to help them understand the material better, but doing so did not result in better performance. We interpreted the results to be due to different learning strategies and the manner in which these strategies interact with course content. In courses where students are primarily learning shallow concepts and definitions, the ability to pause lectures may facilitate memorization strategies and thus result in better performance. However, in courses such as calculus where students must learn cognitive skills, memorization strategies may result in poorer performance. In the case of calculus courses, some students may utilize online lectures in such a manner that would allow them to focus on memorizing course content rather than understanding concepts, leading to poorer performance in the course. Based on this speculation, Experiment 2 examined how students' studying approaches are related to their use of online lectures, the pause and seek functions, and course performance in a calculus course (Calculus II for Physical Sciences; MATA36).

2. Experiment 1

In Experiment 1, we were interested in how Bassili and Joordens' (2008) results would compare to those obtained with the context of a mathematics course. Bassili and Joordens conducted their study in an Introductory Psychology course, a course that focuses primarily on teaching theories, definitions, experiments, and perspectives that form the field. Relative to a mathematics course, an Introductory Psychology course involves less emphasis on learning procedural skills that are needed to solve mathematical problems. We predict that the performance advantage documented by Bassili and Joordens might be especially potent in the context of mathematics. That is, mathematics courses require that students keep up with the material because work builds incrementally. Mathematics also has a much larger emphasis on the deep learning of specific cognitive skills (Biggs et al., 2001). So, allowing students to watch the lectures again may help students with understanding the demonstrations and with homework problems.

2.1. Methods

2.1.1. Enrolment and participants

Participants in the study were enrolled in our MATA30 and MATA32 classes. Near the end of the term students were informed that we were performing research on their usage and satisfaction with the webOption, and they were invited to fill out an online survey. To motivate participation we had draws for iPod music players, with students informed that their name would be entered in the draw if they filled out the survey. For ethical reasons, the professors of the respective courses were not informed which students participated, and no component of the class was in any way linked to participation. Confidentiality was strictly maintained.

2.1.2. Materials

Lectures were made available online by capturing them in-class on videotape and by uploading a compressed digital video file to a server where they could be accessed by means of streaming video in realplayer format. Pilot research has demonstrated that students find the quality of the video image and of the sound satisfactory (Bassili & Joordens, 2003).

2.1.3. Procedure and measures

Students viewed the lectures using the free version of realplayer. Like most media players, realplayer offers the ability to pause the media, and to navigate forward and backward through it via a seek bar. Our research will consider how often students choose to watch lectures via this medium, which features they used and how often, why they used the features, and whether using the features lead to a performance advantage. We obtained this data via an online survey containing 50 questions, a subset of the questions used by Bassili and Joordens (2008) augmented by some questions especially related to mathematics. In this paper, we focus primarily on the questions highlighted by Bassili and Joordens in order to compare findings across the Psychology versus Mathematics contexts (see Appendix A).

2.2. Results and discussion

Table 1 provides a breakdown of students' responses with respect to how many lectures they attended, viewed online, attended and viewed online, or missed completely. Across four questions they were asked to estimate the number of lectures they experienced in each format using the categories indicated in Table 1. There were 24 lectures in total during the fall term. As the data suggest, over 50% of the students attended over half of the lectures even when the online lecture option is available. That said, the online lectures are also being heavily utilized with over 40% of the students watching at least half of the lectures online. Students sometimes attend and watch lectures online, but most do so for only a small percentage of classes. Less that 10% of students both attend and watch more than half of the lectures online. These patterns seem relatively stable across the two math courses.

As presented in Table 2, there were also some expected correlations with respect to how students viewed the lectures. Those students more likely to attend lectures were less likely to watch online, $r(490) = -.64$, $p < .001$, but were more likely to both attend and watch online, $r(490) = .31$, $p < .001$. Those more likely to watch lectures online were also more likely to both attend and watch online, $r(490) = .26$, $p < .001$. Given that doing both requires one to both attend and watch online, these last two correlations are hardly surprising. However, the relatively strong negative correlation between attending versus watching online does suggest that most students prefer doing one or the other.

When students do watch lectures online they appear to utilize the features provided by the media player. Descriptive statistics concerning usage of the media-player features are presented in Table 3, alongside the previously published findings for Introductory Psychology (PSYA01). The first obvious finding is that students use the pause and seek features extensively and more so in the mathematics courses than they did in the psychology course. Approximately 77% of the students in the mathematics courses would pause lectures at least once per lecture, and over 52% would use the seek bar at least once per lecture. Pausing was used primarily to take notes, or to consult the instructor's notes, whereas the seek function was used primarily to revisit parts of the lecture. This high level of feature usage suggests that students perceive them to be valuable in terms of allowing control over the information flow from lectures.

The correlation between use of the pause and seek functions was positive for both MATA30, $r(196) = .24$, $p < .001$, and MATA32, $r(292) = .45$, $p < .001$. Thus, as was previously observed in PSYA01 ($r = .28$), those students who utilize one of the features are also more likely to utilize the other. That said, the correlations remain relatively modest, suggesting that some students use one of the features more heavily than the other. In addition, use of the pause features was positively correlated with a tendency to either watch lectures online, $r(490) = .10$, $p < .001$, or to both attend and watch online, $r(490) = .13$, $p < .001$. Given that these features are only provided in the online environment, these correlations are expected. All of the above suggests that students are utilizing the online lectures when they are made available, and that they also utilize the unique features provided within the media player.

This leads us to the primary issue: Do students who use the online lectures and the features of the interface achieve better performance? As an initial analysis we correlated the various indicators described above with students' final grade in the class. Recall that in our previous research in the context of Introductory Psychology we did find modest positive correlations between use of the pause and seek features and performance on a high-stakes exam, and we expected perhaps stronger correlations here. The relevant correlations are presented in the rightmost column of Table 2.

The surprising result is that while final grades in the course were unrelated to most variables, they were negatively related to use of the pause feature, $r(490) = -.11$, $p < .001$, and also to the tendency to both attend and watch lectures online, $r(490) = -.22$, $p < .001$. That is, opposite to our previous findings in the context of Introductory Psychology, reliance on the media-player functions, and the tendency to both attend and watch lectures online, was associated with worse performance in the course.

One explanation of this result revolves around what might be called student-specific characteristics. Most students find mathematics challenging, but some find it downright impossible. Perhaps there are students who simply cannot grasp the concepts, and hence end up with low final marks, but their performance does not reflect a lack of trying. That is, perhaps these students know how challenging they find mathematical concepts and thus they show the highest tendency to both attend classes and watch online, and the highest tendency to pause lectures often to take it in slowly, and yet they still do not get the concepts. If this possibility is correct, we would expect the negative correlations we observed to become less negative as we consider only higher performing students.

Table 1
Breakdown of number of lectures attended, viewed online, both, or neither expressed as the percentage of students within each response category.

	Attended	Online	Both	Neither
MATA30	*n* = 196	196	196	196
None	6.1	2.6	49.0	71.9
1–5	17.9	32.1	32.1	25.0
6–10	10.7	13.3	9.7	2.0
11–15	14.3	13.3	5.6	0.0
16–20	17.3	15.3	2.0	0.5
21–24	18.9	11.7	0.5	0.5
All	14.8	11.7	1.0	0.0
MATA32	*n* = 292	293	293	292
None	1.4	4.8	46.8	76.7
1–5	8.6	40.6	33.1	20.2
6–10	10.3	17.1	7.2	1.0
11–15	13.0	15.7	5.8	0.7
16–20	16.4	9.9	2.4	0.7
21–24	28.1	5.8	1.7	0.3
All	22.3	6.1	3.1	0.3

Table 2
Correlations with among responses, and with final grade.

	Pause	Seek	Attended	Online	Both	Grade
Pause						
MGTA30		.24**	−.06	.15*	.13	−.17*
MGTA32		.45**	−.01	.07	.13*	−.08
Combined		.38**	−.03	.10*	.13*	−.11*
Seek						
MGTA30			−.05	.07	.06	.00
MGTA32			−.07	.11	.08	.07
Combined			−.04	.08	.08	.05
Attended						
MGTA30				−.74**	.35**	−.03
MGTA32				−.53**	.29**	−.09
Combined				−.64**	.31**	−.04
Online						
MGTA30					.08	−.08
MGTA32					.40**	−.04
Combined					.26**	−.07
Both						
MGTA30						−.33**
MGTA32						−.19**
Combined						−.22**

* $p < .05$.
** $p < .01$.

Table 3
Percentage of students (total responses in parentheses) who indicated the specified reason for using the specified media-player function.

	MATA30	MATA32	PSYA01
Overall use of pause	74.0 (196)	80.8 (292)	60.0 (205)
To write notes	76.5	71.2	46.7
Consult the textbook	31.6	27.7	
Consult classmates	1.0	3.1	
Take a break	63.3	52.7	43.0
Read instructor notes	50.5	59.6	
Overall use of seek	50.5 (196)	53.9 (293)	42.0 (205)
Rewatch lecture	78.1	73.0	62.9
Skip to future location	36.2	42.3	10.8
Continue from last view	54.6	49.5	19.2

While plausible, subsequent analyses do not support this explanation. We examined three additional subsets of the data related to students who scored better than 50%, better than 60% and better than 70% respectively. The negative correlations observed in the data set were present for all subsets, and showed no indication of systematically changing in strength. In addition, all students had completed a diagnostic test of ability prior to taking these courses. When we partialled diagnostic test performance out of the correlations, the negative correlations between final performance and use of the pause button, $r(476) = -.09$, $p < .06$, and the tendency to both attend class and watch online, $r(476) = -.19$, $p < .001$, remained. Thus, these correlations do not arise from differences among students in terms of their general math abilities.

If the correlations do not reflect attributes of the students' abilities, perhaps they reflect differences in learning strategies (Biggs et al., 2001) that interact with course content. That is, it may be the case that some students approach learning by attempting to memorize concepts. Such students might be more likely to rely on the online lectures, pausing them often to take notes or remind themselves of concepts. Such a ''surface'' strategy might work well in the contexts where students are primarily learning definitions, theories, etc. as is more the case for courses like Introductory Psychology. But it could actually be a counterproductive in courses where one truly learns by working through novel problems, generalizing the examples in-class to new situations. The students who attempt to memorize may feel like they are learning the class content, and they may be, but if the assessment focuses on deep learning and the ability to transfer cognitive skills, then knowing the lecture content may be insufficient.

3. Experiment 2

In Experiment 2, we follow up on the results found in Experiment 1. We interpreted Experiment 1's results to be due to different learning strategies and the manner in which these strategies interact with course content. We predict that in courses such as calculus where students must learn cognitive skills, the ability to pause lectures (and thus memorization strategies) result in poorer performance. That is, some students may utilize online lectures in such a manner that would allow them to focus on memorizing course content rather than understanding concepts, leading to poorer performance in the course. Thus, Experiment 2 examines how students' studying approaches are related to their use of online lectures, the pause and seek functions, and course performance in a calculus course.

3.1. Methods

3.1.1. Enrolment and participants

Participants were enrolled in our MATA36 (Calculus II for Physical Sciences) class. Near the end of the winter term students were informed that we were performing research on their usage and satisfaction with the webOption, and they were invited to fill out an online survey. To motivate participation we had draws for iPod music players; students were informed that their name would be entered in the draw if they filled out the survey. For ethical reasons, the professor of the course was not informed which students participated, and no component of the class was in any way linked to participation. Confidentiality was strictly maintained.

3.1.2. Materials

These were identical to those of Experiment 1.

3.1.3. Procedure and measures

We assessed how often students choose to watch lectures via realplayer, which features they used and how often, why they used the features, and whether using the features lead to a performance advantage. We obtained this data via an online survey containing 63 questions, a subset of the questions used by Bassili and Joordens (2008) augmented by some questions especially related to mathematics.

We were especially interested in the impact of making lectures available online as a function of a students approach to learning. Thus, in addition to the previously described questionnaire, we also used Biggs et al.'s (2001) revised two-factor Study Process Questionnaire (R-SPQ-2F) to measure student's learning approaches. The R-SPQ-2F has 2 scales, which can be further divided into four subscales. The two main scales measure the *Surface Approach* (SA) and *Deep Approach* (DA) to learning and studying. Surface Approach can be further divided into *Surface Motive* (SM) and *Surface Strategy* (SS) subscales. Deep Approach can be further divided into *Deep Motive* (DM) and *Deep Strategy* (SM) subscales (Biggs et al., 2001). The surface approach is based on extrinsic motivation, where the goal is to avoid failure with minimum time and effort, leading to rote learning. A student who takes a surface approach focuses on the concrete aspects of tasks, rather than their meaning. The deep approach is based on intrinsic motivation, where the goal is to maximize understanding. A student who adopts a deep approach focuses on the meaning of the task (Biggs, 1989). As the names suggest, the subscales refer to the extrinsic or intrinsic motivation, and the strategies that reflect the surface and deep approach. The subscales' reliabilities were determined by using the Cronbach alpha and were found by Biggs et al. to be acceptable.

3.2. Results

Table 4 provides a breakdown of students' responses with respect to how many lectures they attended, viewed online, attended and viewed online, or missed completely. Across four questions they were asked to estimate the number of lectures they experienced in each format using the categories indicated in Table 1. There were 24 lectures in total during the winter term. Consistent with Experiment 1, over 50% of the students attended over half of the lectures even when the online lecture option is available. As well, over 40% of the students watched at least half of the lectures online. Students sometimes attend and watch lectures online, but most do so for only a small percentage of classes. Less than 10% of students both attend and watch more than half of the lectures online.

Also consistent with Experiment 1, those students more likely to attend lectures were less likely to watch online, $r(64) = -.66$, $p < .001$, but were more likely to both attend and watch online, $r(64) = .38$, $p < .01$. The relatively strong negative correlation between attending versus watching online suggests that most students prefer doing one or the other. The correlation between the use of the pause and seek functions was positive, $r(64) = .414$, $p = .001$, suggesting that students who utilize one of the features are also more likely to utilize the other. Use of the pause and seek features were positively correlated with a tendency to watch lectures online, $r(64) = .29$, $p < .05$, and $r(64) = .28$, $p < .05$, respectively. In addition, the use of the seek feature was positively correlated with a tendency to both attend and watch online, $r(64) = .35$, $p < .01$. As our Experiment 1 suggested, students are utilizing the online lectures when they are made available, and that they also utilize the unique features provided within the media player.

The most surprising findings of Experiment 1 was that those students who both attended lectures and watched them online, and those who used the pause feature the most when watching online, actually performed worse in the course. This finding contrasted with the results obtained in the context of Introductory Psychology, a result perhaps due to the fact that students might successfully rely on a surface strategy approach in Psychology, but doing so in Mathematics just would not work. Thus if those students who both attended and watched online, and those who paused a lot when watching online, were essentially using the online lectures as part of a surface strategy, this could explain the seemingly disparate results. In the current study, both attending and watching online ($r(59) = -.14$, $p > .05$), and using the pause feature a lot ($r(59) = -.31$, $p < .05$), were negative correlated with performance, replicating the patterns found Experiment 1. Only the latter of these relationships reached statistical significance, a result likely due to the lower level of power in the current study (64 versus 488 participants in Experiment 1).

Table 4
Breakdown of percent of lectures attended, viewed online, both, or neither expressed as the percentage of students within each response category.

	Attended	Online	Both	Neither
	$n = 64$	64	64	64
None	10.9	3.1	51.6	78.1
1–5	32.8	25.0	29.7	17.2
6–10	4.7	10.9	4.7	0.0
11–15	12.5	9.4	6.2	1.6
16–20	17.2	9.4	3.1	0.0
21–24	12.5	23.4	1.6	0.0
All	9.4	18.8	3.1	3.1

Table 5
Correlations with among responses, and with final grade.

	Pause	Seek	Attended	Online	Both	Grades
DM	.026	.185	.146	.122	.169	.301*
DS	.101	.198	−.017	.310*	.287*	.195
SM	.013	−.014	−.151	.096	.207	−.053
SS	.281*	.149	−.157	.130	.066	−.423**
DA	.065	.204	.088	.226	.243	.284*
SA	.147	.087	−.200	.137	.116	−.270

* $p < .05$.
** $p < .01$.

Table 5 provides the correlations between the R-SPQ-2F scales, usage of the pause and seek features, tendency to attend and/or watch online, and final grades in the course. Consistent with what Biggs (1989) and Biggs et al. (2001) would predict, students who adopted a deep motivation and deep approach performed better in the course, $r(58) = .30$, $p < .05$, and $r(56) = .28$, $p < .05$, respectively. Students who adopted a surface strategy not surprisingly performed worse in the course, $r(55) = -.42$, $p < .01$.

Next we turned to an examination of a potential link between learning strategies and use of online lectures. As we expected, students who adopted a surface strategy tended to use the pause feature more often, $r(60) = .28$, $p < .05$. However, the tendency to both attend lectures and watch online, and the tendency to only watch online were positively correlated with adopting a deep strategy, $r(62) = .31$, $p < .05$, and $r(62) = .29$, $p < .05$, respectively. Thus, it seems that online lectures are viewed as beneficial to those who try to understand the lectures deeply, perhaps by allowing them more control over their lecture watching context. But, those who end up pausing the lecture a lot seem to be those who ascribe to a surface strategy. They are likely pausing to memorize, not pausing to understand. It is not the use of the pause button that is the issue, it is what they use it for.

4. Discussion and conclusions

The current paper examined the usage of online lectures, the features they provide, and how students' studying approaches are related to their use of online lectures and its functions, in the context of performance in calculus courses. In Experiment 1, we found that students do use and appreciate the features of the webOption, but that students who augmented their class attendance with online viewing, and those who used the lecture-control features the most, were actually the students who performed most poorly. This may be due to the manner in which students' utilize these features given different learning strategies. Specifically, because memorization strategies are not especially helpful in mathematics courses, some students may use the online lectures, and specifically the pause button, to memorize course content, leading to poorer performance in the course. Not surprisingly, in Experiment 2, the results supported our predictions. We found that those students who adopted a deep motivation and deep approach performed better in the course, whereas students who adopted a surface strategy performed worse in the course. In addition, we found that final grades in the course were negatively correlated to the use of pause feature. Critically, students who adopted a surface strategy tended to use the pause feature more often. However, students who adopted a deep strategy tended to attend lectures and watch online, or tended to only watch online. These results suggest that using the pause feature is related to a surface strategy of learning, which is in turn related to poorer performance in the course. Indeed, our results are consistent with current literature that suggest that web-based learning environments need to correspond appropriately with students' learning approaches in order to achieve successful course performance (e.g., Ellis et al., 2007; Ginns & Ellis, 2007; Haapala, 2006).

It would be a mistake, however, to view these findings as a reason to not provide access to online lectures in mathematics contexts; watching lectures online is not necessarily a bad thing. Some students do utilize the online lectures as part of their deep strategy to learning, which is related to better performance in the course. In addition, many students did indeed utilize the online lectures, some watching over half of their lectures online. Clearly the presence of online lectures provides a great convenience to students and thereby enhances their satisfaction with the learning experience (Bassili & Joordens, 2008).

Instead, the primary message of this paper is that if left on their own devices, some students may utilize online lectures in a manner that is not beneficial to their learning. Specifically, they may be attempting to "understand" calculus by memorizing what occurred within the classes, a tendency that can be detected in the variables measured here (i.e., the tendency to both attend and watch online lectures, and the tendency to pause the online lectures often while viewing). In the absence of online lectures these students may have nonetheless attempted such a surface learning strategy, but this tendency would remain unnoticed. The presence of online lectures may have provided a new tool to support the non-effective strategy, but it is the chosen learning strategy, not the tool, that is the primary problem.

This all leads us to the following recommendation. Providing access to online lectures in a skills-based course such as calculus can provide students with flexibility and convenience; however, students should be instructed on how to use the online lectures to their benefit. Students should not be pausing lectures in order to memorize lecture content, but rather they should be using the online lectures to help them gain a deeper understanding of lecture material.

Appendix A

The video player contains a pause button that allows you to pause and then restart the video. How much do you use the pause button?

Almost never
Only occasionally
About once every hour of lecture
About two or three times every hour
More than three times every hour

If you use the pause button, why do you use it? (You can select as many options as you would like.)

To be able to write down everything the professor says
To be able to consult the textbook while watching the lecture
To be able to consult classmates about lecture material while watching the lecture
To take a break from the lecture
To read over the instructor's notes
I do not use the pause button
Other: ____

The video player contains a seek bar (a slider) that allows you to find a place in the video. How often did you use the seek bar?

Almost never
Only occasionally
About once every hour of lecture
About two or three times every hour
More than three times every hour

If you use the seek bar, why do you use it? (You can select as many options as you would like.)

To rewatch certain sections of the lecture
To skip to a future location in the lecture
To continue watching the lecture from where you last left off
I do not use the seek bar
Other: ____

How many of the 24 lectures did you attend in-class?
None 1–5 6–10 11–15 16–20 21–24 All lectures
How many of the 24 lectures did you watch online?
None 1–5 6–10 11–15 16–20 21–24 All lectures

How many times did you attend class and watched the same lecture online (please count only classes where you watched the same material both ways for at least 30 min)?
None 1–5 6–10 11–15 16–20 21–24 All lectures

How many times did you skip both the in-class and video lecture?
None 1–5 6–10 11–15 16–20 21–24 All lectures

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