EXPERIENCES OF BLENDING

Elementary Calculus for Physical Sciences

A Summary of Student Surveys & Student and Instructor Interviews

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“It was nice to be able to do classes at home, and I think having a face to face component really helps getting to know people, getting a better idea of what’s going on, and you feel a little more involved in it. I think it was also good for stopping me from procrastinating, because you have to be there. All face-to-face you lose that flexibility, and you have to be in school every day. So, yeah I’d take the blended one” (Student).
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1. Introduction

Blended Learning is an instructional approach that fuses face-to-face instruction time and online learning (Alammary, Sheard, & Carbone, 2014; Harris, Connolly, & Feeney, 2009; Means, Toyama, Murphy, & Baki, 2013). Universities around the world are increasingly moving towards blended courses because of the need to use classroom space more efficiently, the demand for greater flexibility in scheduling with changing student demographics, as well as the opportunities that the model offers with respect to increasing engagement in the classroom (Alammary et al., 2014; Bernard, Borokhovski, Schmid, Tamim, & Abrami, 2014; Harris et al., 2009). Since 2014, the University of Alberta has awarded targeted funding to support the implementation of blended learning across the university. This funding was awarded to instructors to transform foundational undergraduate courses into a blended learning format with the aim of improving student engagement and satisfaction.

To date, numerous studies have addressed student engagement in blended learning courses (Bates & Galloway, 2012; Henrie, Bodily, Manwaring, & Graham, 2015; Holley & Oliver, 2010; Montgomery, Hayward, Dunn, Carbonaro, & Amrhein, 2015; Osgerby, 2013; Vaughan, 2010). Many of these studies focus on ways to improve student involvement (Alrushiedat & Olfman, 2013; Holley & Dobson, 2008; Poon, 2012), or promote engagement in the online segment of the course (Chen, Lambert, & Guidry, 2010; S.-Y. Lin et al., 2016; Moskal, Thompson, & Futch, 2015; Tomas, Lasen, Field, & Skamp, 2015). Similarly to engagement, there is a large body of research devoted to investigating student satisfaction in blended learning environments (Hernández Nanclares & Pérez Rodríguez, 2016; Lin, Chung, Yeh, & Chen, 2016; Lo, 2010; Paechter & Maier, 2010; Paechter, Maier, & Macher, 2010; Umek, Aristovnik, Tomaževič, & Keržič, 2015; Wu, Tennyson, & Hsia, 2010). However, it should be noted that most research focuses on a single course, and studies contrasting different approaches to blended learning are uncommon. Furthermore, only a handful of studies have previously addressed partial elements of instructors’ experiences with blended learning (Al-Busaidi & Al-Shihi, 2012; Brown, 2012; Palmer, 2015; Regan et al., 2012; Szeto, 2014), and their overall experience is often overlooked in the literature.

Thus, to address these gaps in the literature, data was collected for each blended course funded at the University of Alberta. The research questions that guided this study were: What is students’ engagement and satisfaction in blended learning? What is the instructors’ experience in developing and implementing blended learning? This research contributes to the body of scholarly literature by comparing student engagement and satisfaction across different blended learning courses at the University of Alberta. These findings may also highlight effective approaches to developing blended learning courses and identify their influence on students’ experience, which could be informative for other instructors at the university, as well as other institutions. Please note that this report only highlights the findings from Elementary Calculus for Physical Sciences.
2. Theoretical Background

In order to explore student engagement, this study distinguished three different levels: behavioral, emotional and cognitive (Fredricks, Blumenfeld, Friedel, & Paris, 2005). Behavioral engagement refers to course participation, and includes all the academic, social and extracurricular activities that are considered critical for achieving positive academic outcomes. This could include asking clarifying questions about the materials if needed, being able to consistently pay attention, following the course schedule, and completing the assignments. Emotional engagement concerns the various reactions to instructors, classmates or the institution that are supposed to influence willingness to complete activities. This could include students’ perceptions of whether the amount and quality of interaction with both instructors and classmates is appropriate, valuing the relationships built with peers, and generally enjoying taking the course. Finally, cognitive engagement refers to student investment and readiness to put in the work necessary to understand complex ideas and master skills that are being taught. This could include going back to the course materials to review, asking themselves questions to make sure they understood, reading extra materials to learn more about the concepts taken up in the course, and students’ perception that the course has helped to improve their understanding of key concepts and skills.

In this study student satisfaction encompassed both students’ satisfaction with the course format and their preferences related to blended learning, as indicated upon completion of the course (Owston, York, & Murtha, 2013). Other measures of student satisfaction included whether or not students believed the online and face-to-face course components enhanced each other, the web resources were helpful, or if they would take another blended learning course in the future if given the opportunity. Owston and others (2013) mentioned that in blended courses, students may experience enhanced time and spatial flexibility, wider and easier access to the learning resources, as well as increased autonomy over regulating their own learning. Moreover, there is some evidence that having both face-to-face and online components allows students to communicate directly with instructors, receive immediate faculty guidance and support if needed, and get involved with other students in the class (Owston et al., 2013).

3. Method

This study used a concurrent embedded mixed methods strategy: a one-shot case study design for the quantitative portion, and then a case study design for the qualitative portion. Seven course conditions were compared amongst students enrolled in the different blended learning approaches. Student participants responded a 10-minute post-test online survey with questions targeting the two main constructs of student engagement and satisfaction. Two subscales were adapted for this study: (1) student engagement (Fredricks et al., 2005) had a total of 15 items divided in behavioral, emotional and cognitive dimensions, which had an internal consistency reliability of .85; and (2) student satisfaction (Owston et al., 2013) had a total of 6 items divided in course format and preference of blended learning, which had an internal consistency reliability of .75. At the end of the survey students were given the option to volunteer for a 40-minute semi-structured interview with questions also targeting the two main constructs. Additionally, instructor participants volunteered for a 60-minute semi-structured interview with questions regarding their experience developing and implementing a blended learning course.

3.1. Setting

Elementary Calculus I for Physical Sciences I (MATH 144) is a course that compose the first of the introductory calculus sequence for Physical Sciences to increase relevancy and student motivation with a discipline-specific approach. The rationale for transforming this course into a blended format was to improve student experience with more opportunities in class for individual and collaborative problem solving. The overall blended learning approach was to present new concepts and example problems through video format instead of lecture format. Transforming some of the current teacher-centered lectures into an online video format enabled in-class learner-centered interactive activities to support students in their assimilation of course content. In this first-year fully blended course students had ongoing access to the resources (most of them were videos, but they were also available in different formats), online assessments with multiple tries, in-class two-stage quizzes (during the first half of the period students write the quiz individually, and during the second half students work in small teams. If the results of the groups quiz are
better than the individual portion, their marks get boosted, if not the individual mark prevails), direct communication with faculty (which favored immediate support), and were encouraged to engage with classmates during lectures.

3.2. Participants

The participants were 38 undergraduate students enrolled in the course over two years (Fall 2014 and Fall 2015). A member of the research team went to the different lectures to explain the purpose of the study and invite students to complete the survey. A link to the survey was provided in their learning management system, and the response rate reached more than 20% of the total number of students. They were 68.2% male and 31.8% female, and they reported having an average GPA of 3.45 \( (SD = 0.28) \), taking an average of 4.63 \( (SD = 0.59) \) courses, and working an average of 2.25 \( (SD = 5.16) \) hours a week during the term they took the course. Students also reported feeling motivated to succeed (31.82% agree, 63.64% strongly agree), and having strong time management skills (45.45% agree, 4.55% strongly agree) (see Figure 1).

**Figure 1. Items about Student Information**

<table>
<thead>
<tr>
<th>Item</th>
<th>Percentages</th>
</tr>
</thead>
<tbody>
<tr>
<td>I am motivated to succeed:</td>
<td>4%</td>
</tr>
<tr>
<td>I have strong time management skills:</td>
<td>14%</td>
</tr>
<tr>
<td>Strongly Disagree</td>
<td>0%</td>
</tr>
<tr>
<td>Disagree</td>
<td>36%</td>
</tr>
<tr>
<td>Neutral</td>
<td>36%</td>
</tr>
<tr>
<td>Agree</td>
<td>50%</td>
</tr>
<tr>
<td>Strongly Agree</td>
<td>56%</td>
</tr>
</tbody>
</table>
RESULTS
4. Results

4.1. Student Satisfaction

As previously stated, one aim of the research was to investigate student satisfaction with the blended course. This was investigated related to the course format and student preference of blended learning. Each of these areas will be discussed below.

4.1.1. Satisfaction with Course Format

*Figure 2. Items about Student Satisfaction with the Course Format*

On the student survey, students reported positive attitudes in regard to the course format. They thought the eClass site was well organized and easy to navigate (31.82% agree, 59.09% strongly agree), and that the online and face-to-face course components of the course enhanced each other (54.55% agree, 27.27% strongly agree). Students also reported that the online lectures were beneficial (31.82% agree, 45.45% strongly agree) and web resources were helpful (50% agree, 27.27% strongly agree) (see Figure 2). Additionally, while a large number of resources were made available to students in this course, students reported that they did not feel overwhelmed with the information and resources in the course (27.27% disagree, 13.64% strongly disagree), and did not have technical problems associated with accessing materials (27.27% disagree, 54.55% strongly disagree) (see Figure 3).
Student Anecdotes about the Course Format

The utility of resources in the course was a theme that also emerged from student interviews. While some students indicated in the interview that they initially struggled to find the connection between the different components of the course, once they became more familiar with the format they understood how different course components enhanced each other. In the interviews, students were able to articulate the importance of the content in the online videos and how these concepts were applied as practical examples during lectures and assignments.

In their interviews, students mentioned that the combination of all available web resources were one of the major highlights of the course. They recalled that the eClass course site was well organized and easy to navigate. Among the different resources available, the online video lectures were some of the most appreciated by students. They liked how the instructor wrote down the complete solution for the equations, making the videos feel like overhead notes of a real lecture. They also emphasized that the professor was particularly engaging: he was “a whimsical guy that usually opened his videos with a fun music interlude, because he’s a musically talented person. He liked to open with something interesting, so I remember once he went to Banff, and he filmed his video from a mountainside somewhere” (Student).

An additional benefit of the course format identified by students was the availability and flexibility of being able to access online materials. Having the course materials consistently available online allowed them to review videos, summary sheets, class notes, and even pre-class quizzes on their own time, as many times as they needed in order to understand the content of the course. For example, one student stated: “it wasn’t like a set time, it was whenever I had time to do it, and I could spend as much time as I wanted on it” (Student).

Instructor Perspectives about the Course Format

Instructors indicated that the experience of developing and implementing this course was time-intensive. Modifying the course required clearly outlining the learning objectives, determining scheduling and pacing of content, and the creation of the different course materials. An instructor indicated that this process was so time consuming that it became detrimental to other areas of their academic life. “I couldn’t conduct too much research while I was teaching these courses, which is not good in general. I’m tenure, so I can take the hit, but you can’t ask a professor to do that. So finding time was clearly the main challenge” (Instructor).

Development of this course was particularly time intensive for instructors because they were not only challenged to transform a regular calculus course into a blended course, but to also create a new stream of calculus that was applied to the physical
sciences. One instructor described this process as a “rejuvenation of the course. You're forced to really think about what is it that we want to teach in calculus. And just having those conversations with instructors is a very positive influence in the department, just to touch base and exchanging ideas. Why are we teaching this topic? Could we get rid of it? What would happen if we got rid of that topic? That kind of thing” (Instructor).

Thus development of this course required instructors to not only re-think content delivery, but to also reexamine what content was most relevant and important to convey to students

While course development was initially time consuming, the instructors did highlight that subsequent offerings of the course only required minor content updates. Moreover, the instructors felt that because the course is now so well developed, if a new instructor was added to the team, they would only need access to the course content, and a quick tutorial on typical delivery to help get them up to speed. Thus, they felt that preparation required for this course for a new instructor would be analogous to the preparation time required for a traditional lecture approach.

Despite the considerable time investment required for course development, instructors felt their efforts paid off not only because students provided positive feedback about the different course components, but also because the instructors valued the materials and tools they developed to assist in their teaching. Instructors particularly valued resources or tools which allowed students to review the material as many times as they needed in order to fully understand the concepts, at times where it was most convenient for students. These resources included but were not limited to pre-class videos, WebAssign practice quizzes, Socrative questions during lectures, online summary sheets, and CrowdMark submissions.

Despite the success of the course overall, the instructors did highlight technical issues related to building physical infrastructure that prohibited the full development of their ideas. As one of the instructors suggested, “maybe these are just teething pains, but the university wants us to do these kinds of things, and then you realize we're not quite ready for it still” (Instructor). The biggest issue they had with the classroom was the inability to connect their devices (tablets) to the teacher podium wirelessly, which would have enabled them to walk around the classroom while presenting the material instead of standing in front of the class. Unfortunately, there was insufficient bandwidth capacity to support the connection of multiple devices concurrently, and the podium lacked an HDMI connector.

One aspect that instructors highlighted that may have contributed to the success of the course was how they presented it to students. For example, there were some of aspects of the course that needed to be determined or modified as the course progressed, (ex how much teaching assistant support was needed) “But we just went and did it, and the students liked it anyway. I told them from the start that this was a pilot project where I was trying lots of new things. It's going to be fun, it's going to be exciting, and they all got on board. And so they didn’t expect it to be polished, and in my opinion, that’s the way to go” (Instructor).
4.1.2. Preference of Blended Learning

Figure 4. If the same course was being offered in different formats, which course format would you prefer?

Figure 5. If you had a choice between participation in classroom or online discussion, which one would you choose?

Figure 6. If you had a choice between attending lectures face-to-face or accessing lectures online, which would you choose?

Students enjoyed the blended learning format of the course and were satisfied with the course overall. Survey results showed that, when given the option, students would choose blended learning if the same course was being offered in different formats (86% blended learning) (see Figure 4). Students also indicated they preferred to participate in different types of discussion as offered through a blended course (50% blended learning) (see Figure 5). Further, results also showed that students strongly preferred attending lectures face-to-face (82%) over online (18%) (see Figure 6). Additionally, 86% of students were satisfied with the course (68.18% agree, 18.18% strongly agree), and therefore, when given the opportunity most students would rather take a course that substitutes some face-to-face activities with more online components (45.45% agree, 40.91% strongly agree) (see Figure 7).

Figure 7. Items about Student Preference of Blended Learning

Student Anecdotes about their Preference of Blended Learning

Student interviews highlighted that, while there were some initial struggles in terms of time management and workload, students felt that blended learning was helpful because it allowed them to go back and review the content as many times as they wanted. Further, they explained that they would probably choose blended learning if the same course was offered in different formats, because they enjoyed the independence and agency they had over their learning process. Being able to practice when they felt motivated was really important for them, and was “very helpful because sometimes you just don’t want to do math” (Student).
4.2. Student Engagement

The Independent Samples t Test is an inferential statistical analysis that demonstrates whether there is a statistically significant difference between the means in the two unrelated groups. In the table below, from left to right you will find the size (N), the mean (M), and the standard deviation (SD) of each sample; the computed test statistic and the degrees of freedom (t), the p value corresponding to the test statistic (p), the 95% confidence interval of the difference (95% CI), and the effect size (Cohen’s d).

<table>
<thead>
<tr>
<th>Variable</th>
<th>Strong</th>
<th>Not Strong</th>
<th>t</th>
<th>p</th>
<th>95% CI</th>
<th>Cohen’s d</th>
</tr>
</thead>
<tbody>
<tr>
<td>Student engagement</td>
<td>17</td>
<td>18</td>
<td>5.747</td>
<td>6.57</td>
<td>52.33</td>
<td>7.16</td>
</tr>
<tr>
<td>Cognitive dimension</td>
<td>18</td>
<td>19</td>
<td>23.39</td>
<td>2.81</td>
<td>21.31</td>
<td>2.45</td>
</tr>
</tbody>
</table>

Analysis of student survey data showed a statistically significant difference in student engagement scores, and its cognitive dimension, between students who reported having strong and not strong time management skills. Results revealed that students with strong time management skills were more engaged in the course (p = 0.034), and more invested in their learning and self-regulation (p = 0.023) than students who reportedly did not have strong time management skills. Student responses related to each of the three dimensions of engagement will be described in greater detail below.

4.2.1. Student Affective Relations and Belonging: Emotional Dimension of Engagement

Survey data indicated that most students agreed that the quality (50% agree, 27.27% strongly agree) and amount (54.55% agree, 13.64% strongly agree) of interaction with the instructor in this course was appropriate. Students also reported that the quality (40.91% agree, 9.09% strongly agree) and amount (50% agree, 4.55% strongly agree) of interaction with other students was appropriate. They liked taking the course (54.55% agree, 18.18% strongly agree), valued the relationships built with their peers (40% agree, 20% strongly agree), and felt connected with other students in the course (45.45% agree) (see Figure 8). Additionally, students reported that they did not feel anxious (40.91% disagree, 18.18% strongly disagree), or isolated during the course (45.45% disagree, 9.09% strongly disagree) (see Figure 9).
Figure 9. Items about the Emotional Dimension of Engagement (Inverted Values)

Student Anecdotes about their Affective Relations and Belonging in the Course

Student interviews provided further evidence that students’ valued peer interaction within the blended course. For instance, in the discussion made possible through the implementation of two-stage quizzes, students highlighted that being able to solve the different problems a second time in the smaller groups contributed to their learning, not only because they were able to discuss different approaches to the questions, but they also got immediate informal feedback on their performance. In addition to discussion during lecture, students mentioned that having multiple attempts on the pre-class (online) quizzes allowed them to engage in discussion with classmates outside of class any time they required assistance before they submitted their final attempt.

During the interviews, students also emphasized that the instructor seemed open to suggestions and was very approachable. For example, one student mentioned that after being approached about the assignments being longer than expected, “the professor said everyone is complaining about it, and it did seem to be in the back of his mind, so the last assignment we got was significantly shorter” (Student). In addition, students responded favorably to the inclusion of an open-ended space in the pre-class quizzes where the professor allowed them to communicate any issues related with the content. Students felt this gave them an opportunity to inform their instructor of the most common concerns they were having, and the instructor was able to further explain concepts they were struggling with.

Instructor Perspective about Student Affective Relations and Belonging in the Course

Instructors agreed that the two-stage quizzes bolstered collaboration by allowing students to solve problems individually at first, and then having a second opportunity to engage with the questions in small groups. Students then had an opportunity to improve their grade by discussing the different solutions to the problems, realizing the mistakes they previously made, and getting contiguous peer-feedback on their performance. Instructors recalled that the quiz average was significantly higher in the group quizzes than in the individual ones, and they felt it was related to the benefits from the discussion and the collaboration that took place within the student groups.

“In high school, you always leave the classroom and then you gossip with your friends. Did we get that one right? But this actually gives you the opportunity to have that valuable discussion in your class, and actually having it reflect on your marks, so I’m glad there’s a way to make discussing your math test with your friends acceptable. I’m a fan” (Student).

“One thing I’ve done is two-stage quizzes, so now instead of a midterm I have four quizzes. So they do a first individual part, and then they redo the same exam in groups, and this works perfectly. It’s amazing how interactive the groups are, and they love it. The feedback is really positive, because they realize their mistake right away, and they learn from that” (Instructor).

In contrast to the experience with the two-stage quizzes, instructors felt that the Socrative questions implemented in the course may not have been as effective at encouraging collaboration and dialogue. Despite instructor efforts to encourage them to work
in groups, and “to talk to each other, they still worked by themselves and clicked on the answer. And that was better than not working, but I would have preferred to create the same group dynamic” (Instructor).

Further, instructors mentioned that while they made efforts to offer more office hours and make themselves available for assistance, students did not interact with them as often as they would have liked. Instructors booked a classroom before every quiz and exam for students to go and ask questions about the material, but these sessions were not well attended. However, as one of them said, “I don’t think it was a negative thing, I think it was actually a positive thing. Yes, it took us more time preparing, that was a plus in a way” (Instructor). The reason why this seemed to have happened, as communicated to the instructors by students, was because they did such a great job preparing all the different online resources that students could always go back and review, and spent so much time practicing for the quizzes and the exams, that most students did not seem to need this additional space to inquire about the material.

4.2.2. Student Investment in Learning and Self-Regulation: Cognitive Dimension of Engagement

Based on students’ self-reports, there was evidence that students were invested and learning and showed self-regulation. A large number of students reported going back and reviewing the course materials if they were not understanding the course content (68.18% agree, 27.27% strongly agree), or at least doing something to figure out a concept (68.18% agree, 22.73% strongly agree). In addition, students indicated that the course had improved their understanding of key concepts and skills (68.18% agree, 18.18% strongly agree), that they were engaged in the course (63.64% agree, 13.64% strongly agree), and they asked themselves questions when using the course materials to make sure they understood (63.64% agree, 9.09% strongly agree) (see Figure 10).

Student Anecdotes about their Investment in Learning and Self-Regulation

Student interviews also provided evidence for cognitive engagement. They indicated being more engaged in the lectures that had the Socrative question component, because it allowed them to participate in class without feeling too vulnerable, and then encouraged deeper learning once the question was reviewed with the professor. In addition, student answers during these activities only counted for participation marks, which allowed them to feel less worried about choosing the right answer and encouraged deeper engagement with the content. As one of them mentioned, “sometimes he would do an example and say, you wouldn’t have to solve something this complicated, but something like it, and so it gave us kind of an idea of what was expected and what was required” (Student). Students found “He was giving you exposure to future concepts in a first-year calculus course, and I liked that, because when I managed to get through one of those problems I felt empowered” (Student).
these experiences so positive that they recommended increasing the number of these activities through the term as a way to make lectures more engaging.

Students also highlighted in their interviews that the course was clearly laid out and they understood the expectations of them. They mentioned specific features that enhanced clarity, including but not limited to the syllabus description, email reminders, and in-class announcements. Students felt the instructor always made sure they understood both the material and the assignments of the course.

**Instructor Perspective about Student Investment in Learning and Self-Regulation**

During their interviews, instructors indicated that a major challenge they faced during the implementation of the course was trying to engage students during the lecture component. "I think all of us are still a little bit disappointed about student engagement in the classroom. We would love to find better ways to do that, but it continues to be the biggest challenge. What should the active learning activities be in class? And how do we really get engagement from the students?" (Instructor). This involved finding or creating activities to undertake in class, that were both pedagogically valuable and enjoyable (or engaging) for students. They acknowledged that even though the Socrative questions worked best for this purpose, they could still see some students randomly clicking between the different options without becoming involved in the process of collaborating with other students, simply because they knew that the instructor was going to review the work afterwards. As such, enhancing student engagement during the lectures is an area that the instructors want to continue to focus on in the future.

4.2.3. **Student Positive Conduct and Academic Involvement: Behavioral Dimension of Engagement**

*Figure 11. Items about the Behavioral Dimension of Engagement*

Students reported that they followed the course schedule and completed both graded (54.55% agree, 36.36% strongly agree) and non-graded activities (40.91% agree, 36.36% strongly agree), and being able to consistently pay attention in the course (50% agree, 18.18% strongly agree). Student responses were more divided when it came to their likelihood of asking questions (36% disagree, 27% neutral, 37% agree) (see *Figure 11*). While students reported strong participation in the course, some students also reported that the course required more time and effort compared with others (31.82% agree, 22.73% strongly agree) (see *Figure 12*).

*Figure 12. Items about the Behavioral Dimension of Engagement (Inverted Values)*

Students reported that they followed the course schedule and completed both graded (54.55% agree, 36.36% strongly agree) and non-graded activities (40.91% agree, 36.36% strongly agree), and being able to consistently pay attention in the course (50% agree, 18.18% strongly agree). Student responses were more divided when it came to their likelihood of asking questions (36% disagree, 27% neutral, 37% agree) (see *Figure 11*). While students reported strong participation in the course, some students also reported that the course required more time and effort compared with others (31.82% agree, 22.73% strongly agree) (see *Figure 12*).
Student Anecdotes about their Positive Conduct and Academic Involvement

Students’ participation in both the graded and ungraded aspects of the course was also reflected in the interviews. Even though students were marked on quizzes and assignments, many felt that they were motivated for reasons beyond assessment. Students indicated that the main reason they participated was that taking more attempts helped them learn more: after an incorrect attempt they went back and reviewed the content, talked to a classmate, and then, when they felt more confident, attempted an assessment again.

“It is the process that’s important, and the quizzes and the assignments were meant to help us learn. It didn’t make sense to make us have one try because it’s not a test necessarily. We’re trying to figure out how to do it. So, I found it was actually comforting to me” (Student).

In the interviews, even though some students indicated that it was a lot of work both in class and at home, other students felt the course was a reasonable workload. “It was probably the same amount of work as other courses. Something that was big for a lot of people was that it had to be all done outside of the lecture. But I found it that it wasn’t that much work, especially if you’re taking something with a lab. It was much less than that” (Student). Despite the different perspectives on whether the workload was comparable to other courses, all students agreed that they struggled to commit the time outside of the lectures to complete the many different course components that were each worth a small percentage of their final grade.

Instructor Perspective about Student Positive Conduct and Academic Involvement

Instructors noticed improvements in the level of understanding of the content compared to the beginning of the course. Even though they do not have data to corroborate that their performance is now better, they mentioned that students felt more comfortable solving problems, thinking about the concepts in a broader way, and even appropriately writing math after taking the course.

Similar to the comments of students, instructors had concerns about whether implementing the different course components increased student workload. “I tried to not increase the workload, but I’m pretty sure I did still increase it a little bit. But by making the videos and the pre-class quizzes relatively short, they watch a video, they answer one question, and it is always very simple, because it was not about testing” (Instructor). In addition, the instructors thought that students with a full course load seemed to have more difficulties finishing the assignments, studying for exams, watching the online videos, and attending lectures. For what they were able to witness, some students were not completing a number of the activities that were ‘lower stakes’ (i.e. worth very little of their overall grade). They admitted this is still an area of the course that needs further improvement.

“The difference between the beginning of the course and now is amazing. They get here and they have no idea what math is, because they learn a lot of things in high school, but they don’t learn math, they learn formula and how to regurgitate. But if you ask them to think, they have never done that before, and that has changed quite a bit for most students, and it’s amazing” (Instructor).
CONCLUSIONS
5. Lessons Learned

From students:

- Students enjoyed the different resources they had available: that the videos were almost as a casual lecture given by their instructors, having access to the summary sheets, getting more than one attempt in the quizzes, and being able to access all these resources continuously.
- The two-stage quizzes were another success for students, as well as the interactions that they enabled. They mentioned that students are going to compare answers regardless, so it was nice to have that "immediate" feedback interaction as part of the process of the quizzes.
- Students liked that the instructor always seemed approachable, open to feedback and suggestions from the students.
- They did not like when the lecture did not seem connected to the online portion of the course, or connected to the assignment, so they suggested that more connection between the different components would be ideal. However, generally students did not feel that the course added a lot to their weekly workload.
- Students wished that they could have used the live response system (Socrative) more. They noted that sometimes the lecture would become a little dry, so having more of these activities would help students feel more engaged.

From instructors:

- Having different resources available online was helpful for students. The videos turned out to be one of the most useful resources and they did not require a lot of production time. The summary sheets were also highly appreciated.
- Collaboration was boosted by the implementation of the two-stage quizzes. For instructors, it was evident how performance improved after the group attempt, and additionally students liked the immediate feedback they got from their classmates.
- Instructors mentioned that having resources available online freed up face-to-face time with the students. They mentioned that office hours weren’t as busy, but only because students already had all necessary material online.
- Instructors mentioned having a lot of issues with infrastructure and technology in the classroom. Even though they chose one of the newest buildings on campus, they experienced a lot of connection issues that prevented them from using the technologies to their full potential.
- Engagement in class was also a big issue. Even though they recognized that students liked the live response system (Socrative), they did not engage as much in this activities as they did with the two-stage quizzes.
- The amount of time that was required for this project was an issue for the instructors. They mentioned that they were required to allot more than they were expecting at the beginning.
6. References


