Investigating the Retention Rates in Georgia Tech's Online Master of Computer Science Program

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Abstract – This project seeks to compare the retention rates in online computer science courses at Georgia Tech with their traditional counterpart. Through a series of interviews, surveys, and online course reviews, the cause for retention rates, student satisfaction, motivation and engagement in online courses are explored. Are lower online retention rates innate due to the lack of physical classrooms or are there improvements universities can impose?

1 Introduction

Online learning is quickly becoming an alternative to the traditional classroom. According to a report in 2018, the percentage of students taking one or more undergraduate classes increased from 15.6% in 2004 to 43.1% in 2016 while the percentage of graduate students taking a fully online degree increased from 6.1% in 2008 to 27.3% in 2016 (Synder, 2018). It's cheaper than a traditional education, has flexible hours, and only requires a computer with internet connection. Online learning doesn't have the physical limitations of a classroom, allowing institutions to accept more students. For students in a foreign country or older people who want to pick up another skill, online learning gives them another chance at higher education that is flexible enough to fit into their lives. This results in less homogeneity in student background, age, and experience. Along with the price, the marginal cost for students to sign up for online programs is small. Despite these benefits, 40% to 80% drop out of online classes and 21% want more engagement in their classes (Smith, B. 2010). The ability to engage and motivate students can vary greatly depend depending on the university and online program; however, retention rates on average are 10 to 20% lower for online courses than their traditional classroom counterpart (Herbert, 2006). It's not just course retention rates that are higher for traditional classrooms. The 2010 US News and World Report found that the average retention rate for online colleges is 55% compared to 77% for traditional universities (Burnsed, 2010). Lower retention rates have been one of the biggest detractors in online learning, but the question is whether it is innate or not. Is the very idea of taking the university experience and putting in online with no physical interactions with students and professors always going to cause lower retention rates? Or are they a function of a lack of student engagement and motivation? These questions are explored within Georgia Tech's Online Master of Computer Science (OMSCS).

2 Related Work

There have been numerous studies investigating the retention rates of traditional and online courses. In 2013, researchers at Colombia's Community College Research Center performed a study of online course outcomes at two large statewide community college systems. They found that for each state, withdrawal rates were 13% and 8% lower for traditional courses than online courses respectively. In addition, the performance gaps that existed in

traditional courses were more pronounced in online courses: in face-to-face courses white students had a 3.0 GPA compared to 2.7 for black students and in online courses the GPAs were 2.8 and 2.2 respectively (Jaggars and Edgecombe and Stacey, 2013). The researchers listed technical difficulties, personal issues, and lack of motivation, physical distance from campus and peers as the main reasons for lower retention rates. In 2016, Papia Bawa completed a literature review of 10 years of research on online and traditional retention rates, finding that several critical factors in high retention rates were "misconceptions learners have about the workload, cognitive challenges, and general expectations". Learners may underestimate the technology savvy required of the courses, leading to demotivation. In addition, instructors may not be experienced or prepared to teach an online course, not understanding what works in a classroom may not work in an online learning environment (Bawa, 2016). Chen, K. & Jang, S. (2010) studied the effect of self-motivation in an online learning environment through three needs: sense of control of learning, competency for tasks, and interaction with other students. They suggest that there are many reasons students take online courses and instructors need to provide students with a reason for why the course is important. Instructors should not "dichotomize students into motivated and unmotivated groups with two students with the same motivation may have very different reasons for participating in a class". By understanding why students want to learn and creating an open, interactive environment for questions and discussions, students will have higher determination and lower uncertainty (Chen and Jang, 2010). There have been cases of a successful implementation of online learning. Researchers from Arizona State University (ASU) investigated the retention rates from three public and three community colleges. They found that retention rates were 9 to 18% higher for students who took a mix of face to face and online courses compared to those who took only face to face (Bailey and Vaduganathan and Laverdiere and Pugliese, 2018). While these findings show the potential in online learning, the researchers mention that the section sizes of online courses in online courses are only 25% greater than traditional courses, while ASU like larger public universities are 50% higher. Thus, it's possible the higher retention rates are a function of a mix of traditional and online courses as well as higher instructor to student ratio (Bailey and Vaduganathan and Laverdiere and Pugliese, 2018).

3 The Solution

A rise in online retention rates will benefit students, instructors and universities. Students who could never go a university due to age, physical distance, job, or money could get an education and open their mind to new topics. But putting students in online courses that result in low retention rates defeats the purpose of providing an education. It is important for universities to understand how students feel about online learning and what steps they can make to improve their programs. This paper explores the topics of student motivation, engagement and satisfaction as a proxy for retention rate through a set of surveys, interviews, and online reviews. Using these different sources, a set of guidelines are provided for universities to improve the online learning experience.

4 Methodology

Before investigating retention rates in OMSCS, the first step was to determine if retention rates were lower in online courses vs. their traditional counterpart. A website called Course Critique contains both retention rates and grade

distributions for all Georgia Tech class, semester, and section. This was useful since online and traditional computer science courses had different section names, so it was possible to directly compare traditional and online retention rates. The data was not easily scrapable since it did not show up as HTML on the website, so the tables were manually copied and pasted into an excel spreadsheet. This was completed for twenty-one courses through three online programs: computer science, analytics, and cybersecurity. Ideally the data set would consist of hundreds of courses, but for the course to be included there had to be both online and traditional sections with a large enough class size. After obtaining the retention rates, the differences between online and traditional courses was investigated through surveys, course reviews, and interviews from current Georgia Tech graduate students (most in CS). Surveys from thirty-eight students from a mix of online and traditional learning programs were collected about their motivation, support systems and reasons for student satisfaction in online courses. Due to the small sample of survey responses, reviews from OMSCS students were collected from a website called OMS Central. In addition to a review, students provided their satisfaction rating (1-5), workload (hours per week), and difficulty (1-5) of the class. The site aggregates hundreds of reviews to provide the overall difficulty and satisfaction of the course. Scraping and parsing these reviews for the highest retention courses provided information about student satisfaction in the course and in some cases why they dropped it. Only reviews since 2019 were included to account for courses changing structure. Lastly, a set of four interviews were conducted with current graduate level students in computer science. Three students were in OMSCS while one was in traditional courses before they were moved online because of COVID. Each interviewee was asked seven questions detailing their experience, motivation and satisfaction in online courses. The combination of these data sources was used to find patterns in student satisfaction in online courses. Because there is a survival bias in students who drop out of courses, student satisfaction rates were used as a proxy for retention rates. The assumption was that students who were more dissatisfied and unmotivated in courses were more likely to drop it.

5 Results

The results of the data collection explore how students in OMSCS feel about engagement, motivation and satisfaction in their online courses. The surveys provided how these factors were related while interviews and course reviews gave explanations for why students felt this way in online courses.

5.1 Comparing Retention Rates in Georgia Tech Courses

Before investigating the retention rates in OMSCS courses, it must be determined what were the retention rates in these courses and how do they compare with their traditional counterpart. Using data from Course Critique, the dropout rate (one minus the retention rate) distributions are shown in the density plot in Figure 1. Online courses have a higher average dropout rate compared to traditional (its distribution is shifted to the right) although both are normal. The online distribution has a higher standard deviation meaning there is a larger range of retention rates compared to traditional courses. A p-test was run to determine if the means of each distribution were significantly different. The p-value was <0.05, so online retention rates were significantly higher than traditional courses for OMSCS.

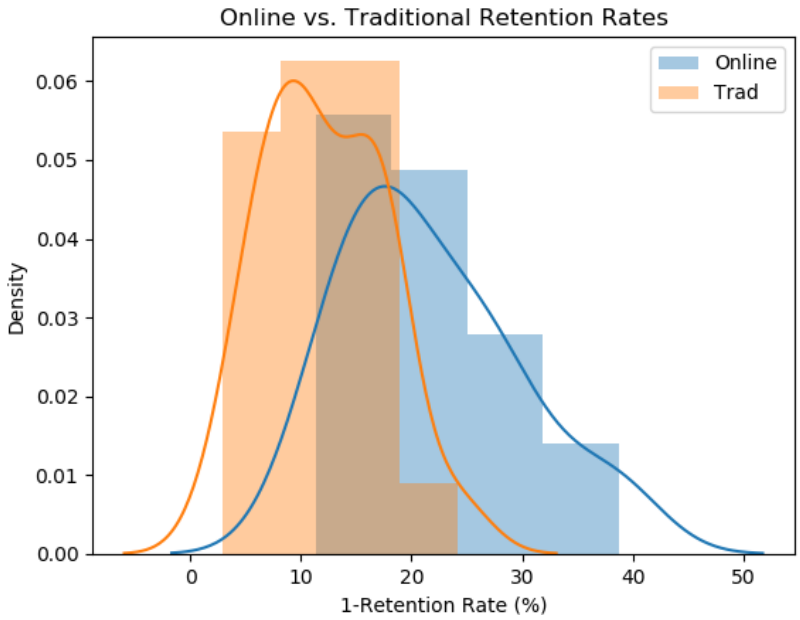

Figure 1: Distribution of OMSCS Course Retention Rates

5.1 The Effect of Difficulty and Workload on Online Retention Rate

The next logical question was if online and traditional retention rates were correlated, and if lower retention rates were a function of course workload and difficulty. A series of scatterplots are shown in Figure 2. The left plot shows the relationship between online and traditional retention rates. A linear regression line was plotted in blue, and the r-squared and p-value are displayed as well. The r-squared and p-value were 0.09 and 0.67 respectively, showing little correlation in retention rates. In the middle, the online retention rate is plotted as a function of average workload (hours per week). The right grid shows online retention rate as a function of course difficulty. As expected, both showed strong correlations. Students in more difficult and work intensive courses were more likely to drop them. This is an important point to address because the background and makeup of OMSCS is diverse. Some students have very little computer science experience while some have been doing it for years. Some students are coming straight from college while others are middle-aged and married with kids. Students take these courses for different reasons, but throughout the hundreds of reviews, workload and difficulty were correlated with retention rates.

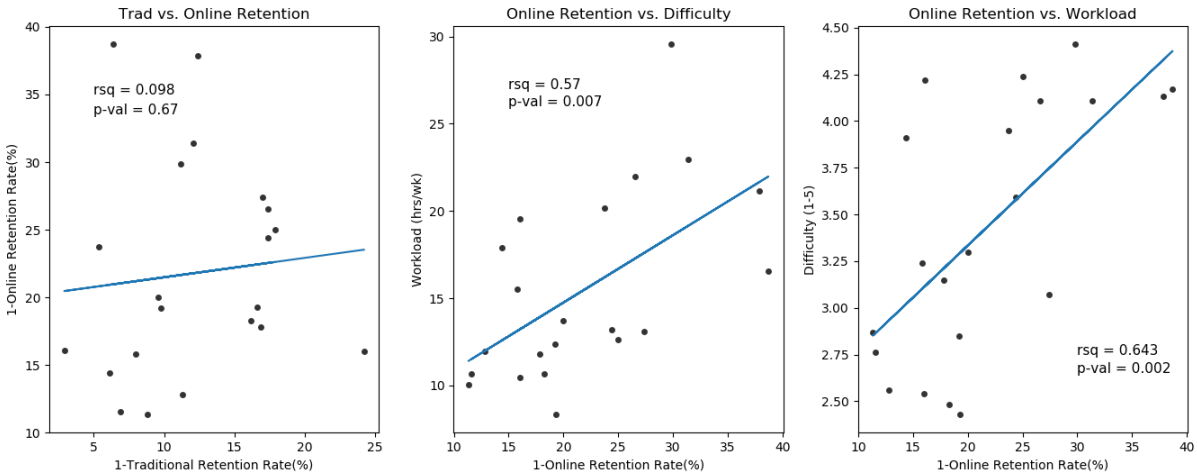

Figure 2: Correlation Plots of Retention Rate, Course Difficulty, and Workload

5.1 Investigating the Lowest Course Retention Rates

The top five lowest retention rates were shown in the bar plot in Figure 3. The top five lowest retention courses were Advanced Operating Systems, Machine Learning, Artificial Intelligence, Big Data for Health Informatics, and Network Security. The retention rates of the traditional courses were in green for reference.

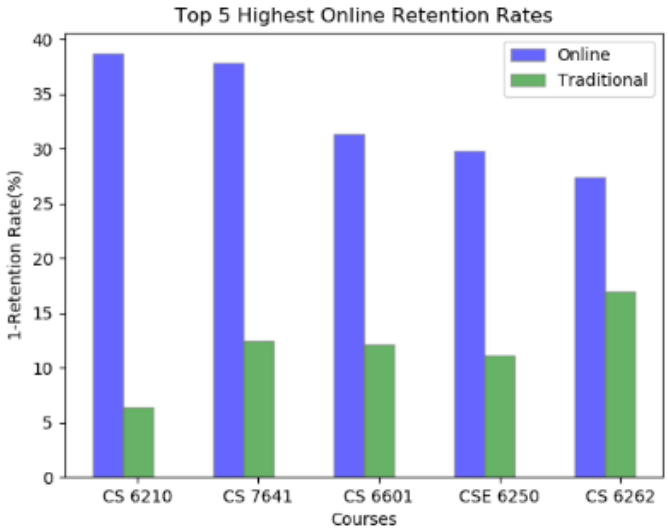

Figure 3: Bar Plot of Top Five Lowest Retention Rate Courses

To delve deeper into the low retention rates of those five courses, reviews of students who took those courses were scraped from OMS Central. This resulted in 261 reviews. As mentioned in the methodology, there was an inherent sample bias in the students writing reviews, most in the strongly like or dislike categories. This was clearly shown in Figure 4, which plotted percentage of each satisfaction level. Of the 261 reviews, 79 were negative resulting in a dissatisfaction rate of 30.2%. While students who wrote a bad review may not have dropped the course, the percentage of reviews that disliked the course was similar to the average dropout rate of those five courses (~30%).

Of the 79 students who either disliked or strongly disliked a course, 15 of them expressed they dropped the course, resulting in a retention rate of 81%.

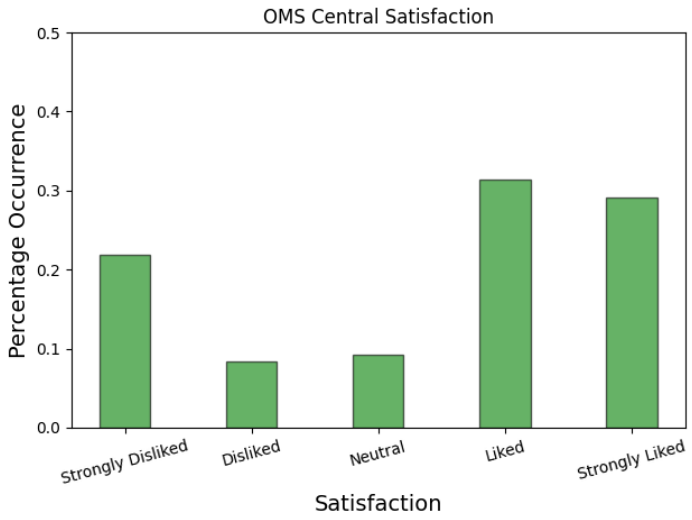

Figure 4: Bar Plot of Top Five Lowest Retention Rate Courses

To determine what led to student dissatisfaction in these courses, the reviews were filtered for any negative review then text parsing was used to create three categories: outdated material/technology, unclear instructions and assignments, and no support from professors or TAs. The reviews were parsed for specific key words or phrases such as absent, unmotivating, outdated, depreciated, confusion, unclear, and ambiguous based on the three groups. The percentage of negative reviews for each group is summarized in Table 1. The highest percentage of negative reviews come from lack of support from professors and TAs while the second highest was due to ambiguity in coursework.

Table 1: OMS Central Negative Review Summary

Reason for Dropping Course (N = 79)	# of Reviews	% of Reviews
Outdated Material/Technology (outdated, depreciated, inefficient)	7	8.86%
Ambiguity in Coursework (ambiguity, clarity, poorly written, confusing, unclear, too open ended)	26	32.9%
Lack of Support from Professor/TA (unmotivating, lack of support, absent, no feedback, not responsive)	38	48.1%

5.2 Student Interaction in Online Courses

A set of surveys were collected from a mix of students in traditional and online courses to collect information about their background, motivation, satisfaction, and if they dropped a class. A series of bar plots were used to visualize

the results. Overall, there were 38 students who completed the survey. Figure 4 showed the percentage of respondents in online learning, in computer science, with a full-time job and prior experience in their current program. This adds context to the results. Over 70% of respondents were in OMSCS and working a full-time job (40-50 hours). Only 15% of respondents had *no* prior experience in their current program. Most respondents were employed full time with prior experience in their field, so they had other priorities than school.

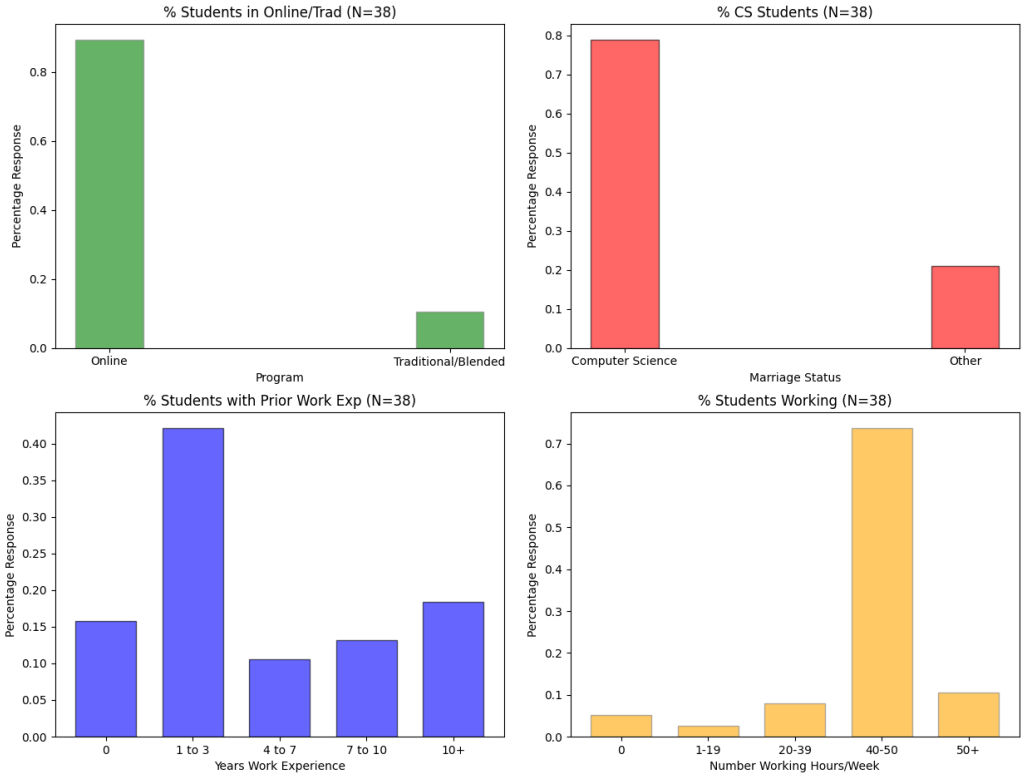

Figure 5: Bar Plot of Student Background from Surveys

Figure 6 shows four different bar charts of student agreement with different aspects of their courses. The top left bar plot shows that only 40% of respondents agreed that they had sufficient interaction with instructors, teaching assistants (TAs), and other students while over 80% of respondents agreed that more interaction would result in higher satisfaction in the course. These results line up with one of the biggest criticisms of online learning: there is not enough interaction between students. All four interviewees felt there needed to be more interaction with instructors and other students, and Piazza and OMSCS slack groups were good platforms for this. Unlike traditional classrooms were there is a limit on the number of students because of the size of the classroom, there is no limit for online courses. This creates issues where there are OMSCS courses with thousands of students and only on instructor and a few TAs. While some instructors and TAs are better at interacting and helping students, this creates frustration and isolation for students who cannot receive help. Three interviewees had taken OMSCS courses that emphasized peer review and student participation, saying that it improved their online learning experience, but lack of interaction with students was listed as a reason for dissatisfaction in online courses. Some suggestions for improvements were a platform for students to interact (not slack or Piazza), connect and network with each other.

The traditional learning student was in synchronous online courses compared to the asynchronous courses of OMSCS. He described how difficult it was for instructors who had never taught online courses to gage the students. In a physical classroom, instructors can read the room, so they know when to repeat something, whether to stop for questions, and when to move to the next topic. But in online courses where students often had their cameras turned off, instructors could not do that. This shows the stress of interaction not just for the students but the instructor as well.

5.3 Student Motivation and Engagement in Online Courses

Interestingly, only 5% of respondents did not feel motivated or engaged in their courses and 12% felt there was *not* sufficient support systems in their courses. These results could be a function of the students completing the survey being self-motivated because they went out of their way to complete the survey. In contrast to the survey respondents, all four interview subjects felt less motivated in online courses, but only one (the traditional learning student) attributed this to the courses being online. The three online students listed the fact that OMSCS is part time while their full-time job is their priority, and when they took traditional courses in undergraduate the expectations were different. In traditional courses as an undergraduate, they were younger, had scholarships, and were expected to invest all their time in school. One interviewer described motivation for traditional vs. online courses as "the same motivation but a different type". Rather than motivation based on time investment, it was geared toward what they could accomplish and learn. The traditional learner student described the learning environment as the reasoning for less motivation. Universities are an academic environment where there is constant learning while the home is a place of rest and relaxation, so he struggled to adjust. He explained when there were constantly students studying around you such as at universities, there was a peer pressure that motivated studying. That motivated was missing in online courses.

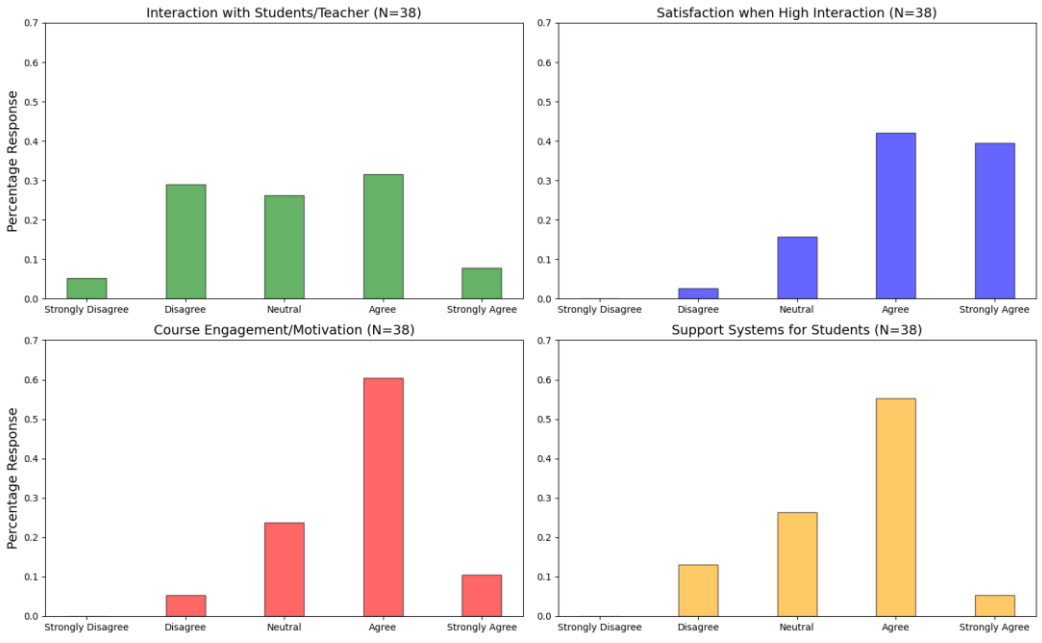

Figure 6: Bar Plot of Engagement, Motivation and Support during Online Courses

5.4 Student Satisfaction in Online Courses

While motivation and engagement are important, understanding what students enjoy about online courses might provide reasoning for why they drop out. Figure 7 showed the percentage of students who selected each option for engagement and satisfaction. Discussion boards and feedback from TAs were selected the most while weekly quizzes had the lowest percentage. This further strengthened the point that student engagement must come through connections and discussions with other students and TAs. Student satisfaction was evenly spread between interesting material, good course structure, and strong communication with TAs and instructors. Giving students real world applications such as additional papers or current public research can give students extra motivation for why the course is important. While course structure is dependent on the class, understanding what students enjoyed about the class and being flexible would improve satisfaction.

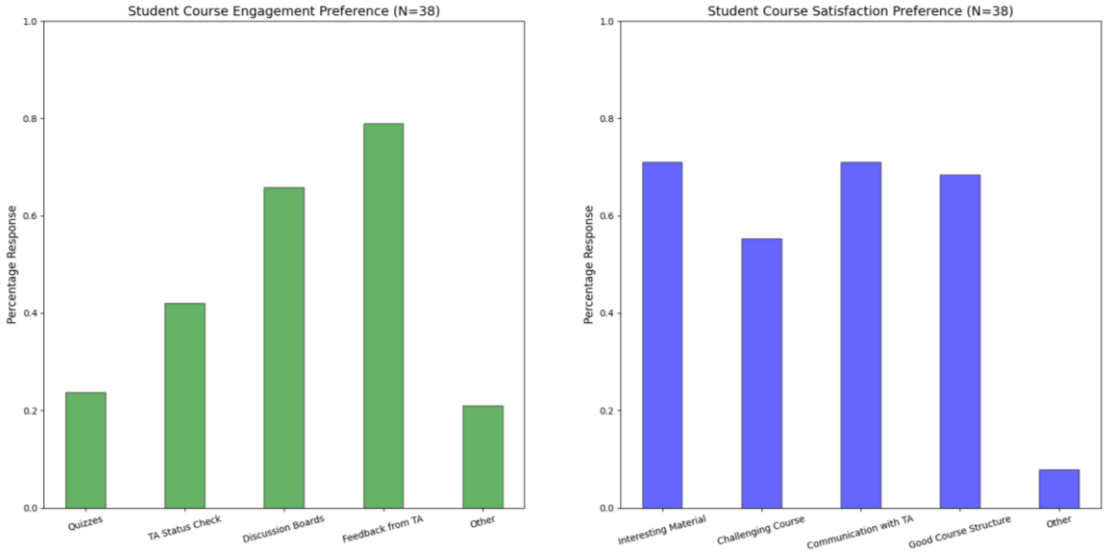

Figure 7: Bar Plot of Student Engagement and Satisfaction from Surveys

The last questions of the surveys asked students whether they dropped a course. According to Table 2, of the 38 students, 23 had dropped a course (60.5%) while of the 28 who said they dropped a course, 13 (46.4%) said they enjoyed the course. Table 3 lists the percentage of students who did drop a course the reasoning why. For example, of the 28 students who dropped a course, 65.2% selected did not have enough time as a reason. The second highest reason was a personal issue. What is most interesting was that engagement from TAs, instructors and students was not a big reason for students dropping out of courses with only 17.4% selecting that option.

Table 2: Drop Percentage Survey Summary

Reason for Dropping Course	Yes	No
Students who Dropped a Course (N=38)	23 (60.5%)	15 (39.5%)
Students who Liked Course they Dropped (N=23)	13 (56.5%)	10 (43.5%)

While students want more engagement in online courses, they are not the primary reason for dropping out of the course. It's important to note that background of these students was computer science with prior experience and full-time jobs (40-50 hours a week), so they may enjoy the course they dropped but not have time to continue it. These points are backed up in the interviews where several respondents described their job as their main priority while OMSCS felt secondary because they were completing it in their spare time. While students want more engagement, the lower retention rates in online courses are a function of the difficulty and workload of the course as well as the lack of the time. It's important to remember the type of students who are in OMSCS. Most do so with a full-time job and wanted the flexibility of asynchronous courses to fit into their busy lives. If the course becomes too much work or a personal issue pops up, they no longer have the flexibility to fit the course in their schedule, which was the main benefit of online courses.

Table 3: Summary of Student Reasons for Dropping a Course

Reason for Dropping Course	% of Students who Selected Response
Did Not Have Enough Time	65.2%
Personal Issue	47.8%
Did not Enjoy Structure of Course	39.1%
Did not Enjoy Material	34.8%
Was not Prepared or Performing Well	30.4%
Little Engagement from TAs/Instructor	17.4%
Other	21.7%

The data collected from the different sources led to interesting results. While retention rate is mostly a function of workload and difficulty (therefore students do not have the time to continue the course), there were clear improvements to student satisfaction. The surveys and interviews made it clear that more student interaction is needed. Some suggestions to "recreate the traditional classroom" from the interviewees were networking events, peer reviews, participation and video discussions. Most OMSCS students have full time jobs and families, so they are completing the courses in their spare time. It is priority will always be lower and they may have the same investment in time and motivation as a traditional learner. If courses and assignments are vague, confusing, and unclear it is frustrating. If students are spending all their time trying to figure out what is required or expected from assignments rather than learning, they will feel the course is not worth the time. In addition, poor instructions cause more strain on TAs since a larger portion of students all need help with the same questions. Having clear assignments and expectations of the course removes those problems. The ASU study showed that online retention rates were higher in community college courses that had a higher TA to student ratio. Having an instructor and TAs who are responsive, accessible and engaged with students creates a better online learning environment.

1. Increase student interaction through other means besides Piazza/slack. This could be peer review, student participation, networking events, and video discussions.
2. Give clear directions on assignments and expectations coming into the course. Doing this prevents more students from needing help, mitigating the issue of too many students and not enough TAs.
3. Instructors and TAs should be responsive and present on different platforms.

6 Limitations

The initial project was to compare the retention rates in traditional vs. online Georgia Tech graduate courses, then investigate the reasons behind that difference. Due to a lack of data (from surveys responses, interviews, etc.), the focus shifted toward investigating improvements in online courses that improve student satisfaction and thus retention rates. Ideally, data would be collected from hundreds of online courses at Georgia Tech from dozens of different majors; however, some online programs are relatively new, so there is less data. OMSCS has years of data on course information and student reviews, so the crux of the project was on computer science students. This reduces the scope of the project, but it means the results and conclusions gathered may not apply for other subjects. Also, projects that rely on student participation for data are prone to sampling bias. For example, there is no immediate benefit for students to voluntarily complete a survey, so the source of the responses are students who are more diligent and motivated. The OMS central reviews are heavily biased toward strongly disliking or liking a course because they went out of their way to write a review about it. Students who were neutral about a course are less likely to be represented. While these sampling biases do not negate the results of the project, they were addressed when discussing any results or conclusions.

7 Conclusions

In conclusion, retention rates in online computer science courses at Georgia Tech were significantly lower than their traditional counterpart (p-value < 0.05). Retention rates in online courses were directly correlated with workload and difficulty of the course. Typically, OMSCS students take these courses because of asynchronous courses are flexible, but that means the courses may not be their top priority compared to a job or family. The survey results showed that not enough time and personal issues were the top reasons students dropped an online course, compared to aspects about the course itself. With student's busy schedules, it's important that online courses have clear directions and expectations for students. In addition, students in online courses felt there was not enough engagement with other students and felt higher levels of satisfaction when there was sufficient engagement. If implemented by universities these guidelines can improve online student satisfaction and learning in online courses.

8 Future Work

This project was done over the course of a few weeks with limited data samples, focusing on OMSCS students, so it is small in scope. Ideally data would consist of thousands of students in traditional and online programs from several schools, so the results could generalize better. On its own, determining useful course reviews from OMS Central could have been a project on its own since some provided useful feedback while others were rants against a bad

grade. With more time, more courses and reviews could have been parsed for additional feedback; potentially for a course that been revamped, one could compare the student's reviews before and after the changes. While this is a separate issue but giving more of a college experience to online students such as events within courses to interact, discuss topics and network could be beneficial for motivation in the course.

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