

IMPACTS OF ASYNCHRONOUS DISCUSSION FORUMS ON STUDENT LEARNING: AN OBSERVATIONAL STUDY

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Abstract

Using asynchronous discussion forums to mimic class discussion and participation has been around for some time but increased dramatically during the COVID-19 pandemic. Much of the current research on asynchronous discussion forums focuses on best practices for implementation but does not address its effectiveness on student learning. This research focuses on quantifying the impact of asynchronous discussion forums on student learning in an introductory principles of microeconomics course. An observational study using two treatments and Ordinary Least Squares (OLS) regression was used to estimate the models. The results indicate that participation in a discussion forum had little impact on student learning compared to an in-person format. The results show a boost in homework scores for upperclassmen but a negative effect on final grades for freshmen, compared to the control group. The results suggest that asynchronous discussion forums boost grades on collaborative assignments but do not translate into higher scores or improved learning on solo assignments such as exams or essays, nor does it lead to any improvement in final grades.

Keywords: asynchronous discussion forum, online learning, microeconomics

JEL Classification: A22

Introduction

The use of asynchronous discussion forums has been a common teaching tool in online courses for decades. However, the recent COVID-19 pandemic greatly increased the use of this activity when schools and universities all over the United States transitioned to online instruction. Data from the National Center for Education Statistics (NCES) reports that “84% of undergraduates experienced some or all of their classes moved to online-only instruction due to the pandemic” (Cameron et al., 2021). As a result of the swift transition to virtual learning, asynchronous discussion forums quickly became the go-to method to reproduce classroom participation and engagement.

Research on distance learning began decades ago with Michael G. Moore’s theory of transactional distance and is still a key work in current discussions (Moore, 1972, 1991). His theory of transactional distance describes the psychological and cognitive distances, rather than geographical, between instructors and learners in virtual settings and how it can impact learning engagement and the attainment of expected learning outcomes. Since then, an abundance of research has been produced related to online learning and its various aspects. Some studies

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describe concerns related to teaching in a virtual environment, such as potential barriers from a policy perspective (Berge, 1998). However, a vast majority of research has focused on how to improve online learning and what is important for academic success in this modality. For example, studies have examined how to increase online engagement (Oliver, 1999), how to reduce procrastination in online environments (Tuckman, 2007), and the importance of using various technological tools to support a broad range of learning styles (Menchaca & Bekele, 2008). However, there is a more limited amount of research dedicated to comparing learning outcomes in in-person versus online settings. Many studies that do attempt to analyze this have issues with very small samples, typically only a class or two, that are carried out over a very short period of time (Davies & Mendenhall, 1998; Johnson et al., 1999; Schutte, 1997).

A much narrower branch of research in online learning has centered around the role of using asynchronous discussion forums in virtual classrooms and the benefits they provide to student learning. The claims made regarding the benefits of discussion forums are largely based on social constructionist principles, where it is believed that opportunities for peer interaction increase knowledge through active “meaning-making” (Fosnot, 2013). Students also benefit from the written interaction the forums provide, which promotes reflection and critical thinking (Liaw & Huang, 2000). Lastly, some studies document the importance of building a strong cohesive learning community for this type of collaborative learning style in order to promote academic success in online classrooms (Menchaca & Bekele, 2008; Waltonen-Moore et al., 2006). Similar to the literature review for online learning, the literature for asynchronous discussion forums focuses extensively on best practices, implementation, troubleshooting issues, and improvement ideas for this learning tool (Anderson et al., 2001; Brown, 2001; Hawkey, 2003; Murphy, 2004; Picciano, 2002). There is little focus on measuring the impact asynchronous discussion forums have on learning outcomes. This gap in research is supported by two studies that separately conclude the research on asynchronous discussion forums needs to be more explicit in measuring learning gains (Wallace, 2003; Zhao & Rop, 2001). This study aims to bridge the current research gap by exploring the efficacy of asynchronous discussion forums and measuring the impact it has on student learning outcomes.

Method

Participant data for this study were gathered from an introductory microeconomics course, ECON 201: Principles of Microeconomics, across several semesters. This class is a survey course in the theory and application of microeconomics. It includes topics such as supply and demand theory, elasticity, taxation, consumer choice, theory of the firm, externalities, and more. The main goal of the course is to introduce students to a theoretical framework for microeconomic analysis and to teach students how to apply an “economic lens” and way of thinking to a range of real-world topics. During the course, students are expected to gain a working knowledge of economic concepts and models, demonstrate technical proficiency in problem solving, and become proficient in the evaluation of real-world applications.

Data were collected from 8 different sections of the course over six semesters between Fall 2017 and Spring 2021. The study was given exempt status approval from the institution’s IRB as it falls under the exempt category 1 for research conducted in established or commonly accepted educational settings. The same instructor taught all sections of the course. The course sections included the same textbook, lecture materials, assignments, and level of exam difficulty. Each course section was relatively small (40 students on average), except for one large double-section taught in Spring 2019 that had 106 students. The modality of the course varied across semesters

and was offered as either in-person, hybrid, or online. The hybrid modality of the course was identical to the online format except that all exam review sessions and exams were held in-person. In the online modality these same meetings were held synchronously over Zoom. Course sections in Fall 2017 and Spring 2019 were taught in-person, sections in Fall 2019 and the first half of Spring 2020 were taught in the hybrid format and starting April 2020 all sections were taught fully online with the outbreak of COVID-19. Since the hybrid and online modalities were virtually identical, as described above, the switch to a fully online modality during the COVID-19 lockdowns likely had minimal impacts on the class². Any effects of the modality transition on students would have been much smaller as compared to face-to-face courses that had to swiftly transition into online formats. The COVID-19 outbreak and lockdown period could have impacted students overall in all their courses due to the uncertainty and stress during that time, so a dummy variable is included to control for such impacts.

Course Setup

To test the impact of asynchronous discussion forums on student learning performance, the participation category of the course requirements was intentionally altered across different course sections. Class participation was either conducted as 1) an asynchronous discussion forum, 2) an online participation response without peer interaction, or 3) in-person class discussions. These three different formats for course setup regarding course participation are discussed in further detail below.

In two semesters (Fall 2017 and Spring 2019), the course was taught in-person and did not include any online participation assignments. For these sections, participation was based on attendance, active involvement in the lectures, and class discussions involving assigned weekly reading articles throughout the semester. Data on these students (N=146) serves as the control group.

In all other semesters where the course modality was either hybrid (Fall 2019 and Spring 2020) or fully online (Fall 2020 and Spring 2021), participation was graded based on attendance and either 1) a weekly asynchronous online discussion forum assignment with peer interaction required or 2) a weekly participation response assignment with no peer interaction. These serve as the treatment groups. Under both treatments, students were provided with a weekly article to read that related course material to a real-world application. Students were then provided with a question prompt challenging them to show their full comprehension of the material. The same weekly articles and question prompts were used in all courses. The treatment applied (i.e., discussion forum or participation response) was randomly decided for each course section prior to the start of the semester, with the only goal over the study period being to have roughly the same number of students in each treatment group.

Students in the discussion forum treatment group (N=116) were required to post a response to the given question prompt and then reply/respond to at least two other classmates' posts by the due date. Students in the participation response treatment group (N=116) were given the question prompt as an online assignment where their responses were submitted directly to the professor. In this treatment group, there was no student interaction or opportunity for peer learning since students did not view other classmates' responses or respond to them. The participation response

²Model results excluding the Spring 2020 semester when classes switched from the hybrid to online modality mid-semester due to COVID-19 are included in Appendix B. These show minor differences compared to when the semester is included, namely the treatment coefficients for freshmen in the final grade model are not statistically significant.

treatment was included to help separate out learning effects from the peer interaction element of asynchronous discussion forums versus any learning effects arising simply from exposure to the weekly article content and application of the material.

In all sections of the course, student learning performance was measured by homework assignments, quizzes, a short essay, three non-cumulative exams, and participation. The weekly homework and quiz assignments were all done through an online publisher-provided platform that accompanied the textbook.³ Data were collected on the average homework and quiz grades for each student. In a few of the most recent sections of the course, quizzes became optional extra credit. As a result, the grade weight for quizzes was shifted into the participation category while the grade weights for exams, homework, and essays remained unchanged. Only the regression model that uses final grade as a dependent variable would be impacted by this change and a dummy variable is included to account for this change. Even with this dummy variable included the results for the final grade model should be taken with a grain of salt. The essay assignment challenges students to come up with an interesting question, seemingly unrelated to economics, and then answer it using concepts from class to test students' ability to apply the material to the real world. The three non-cumulative exams are used to measure the breadth of student learning. Each exam was comprised of 40 multiple choice questions and was worth 20% of the final grade. An average exam grade was calculated for each student to smooth out any differences in course content difficulty across the three exams given during the semester. Raw scores from the exams were used in the analysis before any curve was applied. This allows better measurement of individual student learning and comparability across the various course sections. Lastly, the participation grade category followed one of the three formats discussed above.

Participants

Demographic data on each student were collected from the registrar. The information included cumulative GPA at the time of the course, academic level, declared major, sex, age, and ethnicity. There was also verification that this was their first-time taking the course at the university. The demographic data are summarized in Table 1 and Table 2 below.

Table 1. Participant Demographics for Discrete Variables

Discrete Variables	Frequency	Percent (%)
Freshmen	239	63.23
Upperclassmen	139	36.78
Sophomore	81	21.43
Junior	43	11.38
Senior	15	3.97
Business Majors	281	74.34
Economics Majors	11	2.91

³ There were two updated editions of the textbook during the study period. All lecture material and homework assignments remained the same and were unaffected by these changes. However, the quiz questions are auto generated by the platform and potentially included different questions with each new edition released which could impact quiz scores.

Male	209	55.29
Female	169	44.71
Hispanic	142	37.57
White	116	30.69
Black	25	6.61
Asian	56	14.81
Under 25 Years Old	355	93.92
Total Observations	378	100%

Table 2. Participant Demographics for Continuous Variables

Variable	Mean	S.D.	Min	Max	Obs.
G.P.A.	2.69	0.768	0	4	378
Age	19.75	2.34	17.80	43.55	378

Most students who took ECON 201: Introduction to Microeconomics during the study period were freshmen majoring in Business. This course is a pre-business core requirement to apply for final acceptance into the College of Business Administration. There were slightly more males than females and many students were Hispanic. This is not surprising since the university is a Hispanic-serving institution⁴. The average age at the time of the course was approximately 20 years old, with the vast majority being under 25 years old. The average cumulative GPA was 2.69.

Analyses

Statistical analysis was performed in STATA using ordinary least squares (OLS) estimation. There were four regression models tested, where the dependent variable was either the students' 1) average exam score, 2) average homework score, 3) essay score, or 4) final grade. The first three dependent variables are different measures of student learning which all feed into the determination of the final grade. An upperclassmen variable was created to group all sophomores, juniors, and seniors together. The reason for this was two-fold. First, most students who took the class were freshmen and are unique from the other academic levels since they are new to both the university and college life in general. Second, there were only 15 seniors who took the course during the study period which is roughly 4% of the total participants. Since seniors account for a very small portion of the sample, a single outlier in this group could drastically impact the results making them unreliable. Therefore, the upperclassmen grouping allows them to be included in the analysis.

The independent variables of interest include the two treatment variables, as well as an interaction term between the treatments and upperclassmen. The models also include controls for differences across semesters such as modality, quizzes being required, the double section taught in a large lecture hall, and if taught during the COVID-19 pandemic. Demographic variables include upperclassmen, cumulative GPA, business major, age, sex, and race.

⁴ This study was conducted at a single university whose student demographics are likely to be vastly different than other universities. Therefore, the sample is not likely to be representative of most institutions making the applicability of results limited in their ability to be generalized broadly.

Results

The results, presented in Tables 3 to 6 below, show the estimated effect each treatment had on the four measures of student learning. These are in comparison to the in-person modality control group for each respective class standing. For example, results reported for freshmen in the discussion forum treatment is compared to freshmen in the in-person control group and freshmen in the participation response treatment is compared to freshmen in the in-person control group. There are no comparisons being made across the freshmen and upperclassmen groups.

Exams

The results presented in Table 3 below show no evidence that either treatment influenced average exam scores for freshmen or upperclassmen. These results are not very surprising for a couple reasons. First, as described in the course setup section, the two treatments are related to the participation assignment where students read an article and write a response applying course concepts from that week's material. The exams are a multiple-choice format that cover various analytical, graphical, and conceptual questions. Since there are no essay or free response questions on the exam, it may simply be that students do not use the same skills developed from the participation assignment as they do on the exams. Second, exams are a solo assignment without any help or interaction from peers allowed, meaning there are no collaborative benefits being utilized. Therefore, any learning effects gained by participating in a discussion forum may not translate well into individual knowledge and performance on exams.

Table 3: Treatment Results for Average Exam Scores

	Discussion Forum Treatment	Participation Response Treatment
Freshmen	-2.252 (4.656)	-2.338 (4.750)
Upperclassmen	-0.987 (4.347)	1.036 (5.242)

Notes: Observations=378, Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Homework

The results in Table 4 show a large and highly significant impact on homework scores for upperclassmen who did the discussion forum. Their average homework scores were 17.3% higher compared to upperclassmen in the control group. Likewise, freshmen and upperclassmen who did the participation response performed better on homework compared to the control group, by 11.2% and 12.3% respectively.

Starting with the discussion forum treatment, one possible explanation for the higher homework scores for upperclassmen is that forced peer interaction in the discussion forum served as an ice breaker or otherwise made it easier for students to develop study groups where students could then collaborate on homework assignments. Since there was no effect on freshmen in the discussion forum treatment, it may be that as new students, freshmen are less likely to seek out study groups and miss out on collaborative benefits. However, this would not seem to explain the higher homework scores in the participation response treatment since students had less peer interaction compared to the in-person control group.

The higher homework scores for both freshmen and upperclassmen in the participation response suggests that the participation assignment itself contributed a positive effect on homework. Recall from the course setup, the weekly readings and question prompts were identical

across the treatment groups and control group. In the treatment groups, students were required to write a written response to the question prompt – either on a discussion forum or sent directly to the professor. However, there was no written response required for the control group since the articles and prompts were discussed in class. Without an assignment to turn in, students in the control group may have been less likely to do all the weekly readings. Thus, it seems the content of the weekly reading assignments and forced application of the material through some form of a written assignment led to improvement in homework scores. This positive effect from the assignment itself seems to have been further boosted for upperclassmen who had the forced peer interaction component in the discussion forum. However, the effect seems to have been washed out for freshmen, perhaps due to some unknown negative aspect of discussion forums for this group in particular.

Lastly, the boost in homework scores did not seem to translate into higher grades on the essay or exams, likely because these are more individualized assignments where students could not work together. Also, despite the relatively large boost in homework scores for upperclassmen, final grades were seemingly unaffected which may be because the homework category is a relatively small portion (20%) of the final grade.

Table 4: Treatment Results for Average Homework Scores

	Discussion Forum Treatment	Participation Response Treatment
Freshmen	8.565 (5.776)	11.18* (5.765)
Upperclassmen	17.30*** (5.883)	12.27* (7.039)

Notes: Observations=378, Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Essay

The results presented in Table 5 show no evidence that either treatment influenced essay scores for freshmen or upperclassmen. This result is somewhat surprising since the participation assignment in the treatment groups is most like the essay in that it requires students to apply concepts from class to the real world. Given that the participation assignment requires a weekly written response in either treatment group but not in the control group, one would have expected the increased writing and conceptual application practice to lead to better essay scores overall. It is not surprising that any collaborative benefits or peer learning effects from being in the discussion forum treatment did not boost essay scores since, like exams discussed above, essays are a solo assignment.

Table 5: Treatment Results for Essay Scores

	Discussion Forum Treatment	Participation Response Treatment
Freshmen	-5.622 (8.350)	-8.398 (8.338)
Upperclassmen	-4.657 (8.441)	-4.891 (9.261)

Notes: Observations=378, Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Final Grades

Lastly, the results in Table 6 show that freshmen in both the discussion forum and participation response treatment groups scored approximately 8% lower on their final grades compared to freshmen in the control group. There is no evidence of an effect on final grades for upperclassmen in either treatment group. It is interesting that freshmen in both treatment groups had lower final grades. This may imply that for freshmen, having an additional written assignment to complete each week is more of a drain or burden on them. This would be understandable since they are also adjusting to college life in general. For many freshmen, it is their first time away from home. They are not only getting use to a new environment but are now fully responsible for their academic success. Learning the importance of time management and organization to be successful in all their classes takes time. This could possibly explain why we don't see a negative impact on final grades for upperclassmen who are no longer in this transition period and have gained these skills. This is an important result since most students who take Principles of Microeconomics courses are freshmen, and educators should be aware of potential negative impacts additional assignments can have on them.

Table 6: Treatment Results for Final Grades

	Discussion Forum Treatment	Participation Response Treatment
Freshmen	-7.866** (3.651)	-8.103* (4.239)
Upperclassmen	-3.091 (3.710)	-5.150 (5.005)

Notes: Observations=378, Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Limitations

There are some limitations that readers should be aware of. The first is that even though this study does contain data from eight course sections over six semesters, it still only had 378 total participants due to the small class sizes each semester. A larger sample size would add validity to the study.

Another concern may be the presence of cohort effects. To see if cohort effects exist, we would need to have multiple semesters with various treatments in each semester. This is not realistic and is outside the scope of this paper. However, while this dataset is not rich enough to determine if cohort effects exist or not, testing was done to determine if cohort effects are having a significant effect on the model results. The Spring 2020 semester was used for testing since students in this semester would be considered the same cohort and this semester included two sections of the course that had different treatments: one with the discussion forum treatment and one with the participation response treatment. The results are presented in Table 7 below.

In a roundabout way, this verifies that cohort effects are not impacting the results for exam scores, essay scores, or final grades for freshmen or upperclassmen. It does show they have a positive significant effect on homework scores for upperclassmen in the discussion forum treatment, but no evident impacts on freshmen, which are the majority of the dataset. As discussed above, one explanation is that the higher academic levels have built relationships with their peers who can serve as study partners or offer help on the homework assignments.

Some other limitations to consider are that students in the control group (in-person modality) could have had an advantage in forming study groups since they were in class and had more face-to-face interaction. Students in the treatment groups were either in a hybrid or online

modality where proximity issues may have limited participation in study groups. However, due to the forced virtual learning environment for all courses during the COVID-19 pandemic, students became much more familiar with online platforms such as Zoom which could have easily been used to conduct virtual study groups. Also, the boost in homework scores for the treatment groups seems to support some form of student interaction and collaboration in the virtual modalities.

Students in the in-person format did have an advantage in that they were able to hear questions and answers that were asked during lectures, which may have aided in their understanding of the course material. Also, the in-person lectures guaranteed that students had at least three hours per week exposure to the material. The hybrid and online formats had recorded lectures with the same material and examples problems, but there is no measure of how much time students actually spent watching the lecture material. A control variable for course modality was included in the models, which are displayed in Appendix A. The control variable for modality shows that, compared to the in-person format, students in the hybrid modality scored lower on homework and exams, likely from these differences discussed. Lastly, there is the issue of self-selection which could create various biases if stronger students selected into one class over another. Control and treatment groups were chosen randomly by the instructor without student knowledge, which helps to mitigate this concern.

Table 7: Impact of Cohort Effects

	Exams	Homework	Essay	Final Grade
Freshmen	5.427 (4.766)	3.331 (6.018)	6.457 (9.598)	5.299 (5.061)
Upperclassmen	-2.851 (5.059)	18.32*** (6.167)	0.00909 (12.05)	5.751 (4.776)

Notes: This sample includes only students in the Spring 2020 semester. There were two sections taught: one with the discussion forum treatment and the other the participation response treatment.

Observations=76, Robust standard errors in parentheses. *** $p < 0.01$, ** $p < 0.05$, * $p < 0.1$

Conclusion

To briefly summarize, this paper analyzes the effectiveness of discussion board forums, specifically those in which students post content during a specified period, which constitutes asynchronous participation. In one treatment group, students submitted their posts to the instructor, while in the other treatment group, students posted their content in a discussion forum and then other students were required to respond with comments. The latter approach is considered the “best practice” according to popular online certification organizations, such as Quality Matters (QM). Student performance in these treatment groups were compared with a control group where no written participation assignment was used.

The main finding is that the discussion forum did not ultimately increase learning outcomes. However, there are some differences in performance across class standing. Namely, the discussion forum treatment had a positive effect on homework scores for upperclassmen, but a negative effect on final grades for freshmen. However, this boost in homework scores for upperclassmen did not translate into higher grades on exams, essays, or final course grades. Similarly, the participation response treatment had a positive effect on homework scores for freshmen and upperclassmen, but a negative effect on final grades for freshmen. A reasonable explanation for the outcomes is that upperclassmen formed study groups due to the forced peer interaction of the discussion forum, which in turn led to collaborative efforts on the homework that boosted scores. For freshmen, it seems that having an additional assignment, either through the

discussion forum or participation response, overburdened them as new students and decreased their overall performance in the course.

This research provides helpful insight and measurement of the effect that asynchronous discussion forums have on student learning outcomes. The results call into question the real value that asynchronous discussion forums have in online introductory economics courses. Since the negative impacts are only seen with freshmen, it may be that they have specialized needs adjusting to college life and are easily overburdened by too many assignments during this transition period. Another interesting takeaway is the overall absence of impact on the essay, which was most similar to the participation assignment in the treatment groups. This begs the question of how much does conceptual application to the real world deepen students' knowledge of the material and how much does weekly written practice improve essay skills? Both of which are outside the scope of this paper but would be interesting future research for introductory economics courses.

There are several important implications for instructors who currently use or are considering using asynchronous discussion forums as part of their course setup. The first is to thoughtfully consider the main goal and purpose of discussion forums in their class. The data presented here suggests that in introductory economics courses, discussion forums support collaborative work like homework but shows no evidence of increased learning on solo work such as exams and essays or on final grades. Hence, discussion forums may show a larger benefit to student learning where the course includes group projects or other collaborative assignments. Furthermore, if the main goal of discussion forums in online classes is to mimic the fluid interaction among students that naturally occurs in traditional in-person modalities, then other online chat rooms such as Slack or Discord where students can openly discuss or ask questions on any topic at any time may be more fitting. Additionally, consideration should be given to the added workload and time costs it takes students to participate in discussion forums. This is especially true for freshmen students who showed lower final course grades when participating in the treatment groups. If additional assignments are added to a course, it is very important that they are high impact learning practices. Otherwise, it is likely that learning benefits will be washed out by the added costs to students.

This research also brings into question whether discussion forums are the best tool to deepen students' knowledge and application of the material or if there are better methods available. As many professors can attest, students often just go through the motions of posting and responding to discussion boards without putting in much effort or thoughtfulness. This lack of interest may be caused by discussion boards feeling mundane or tedious, especially if students have multiple courses employing them. In light of this, instructors should consider alternatives to discussion boards or implement creative twists on them to keep students engaged. Some possible ideas to liven up discussion boards are to include things like text annotation tools, video responses (such as Flipgrid), or audio recordings. There are also more interactive forum tools like Perusall or VoiceThread to facilitate discussions around multimedia content. This promotes richer and more engaging interactions beyond simple text-based posts. Some ideas for alternatives to discussion forums are having students do collaborative document creation such as group essays or wikis, concept maps, visual reflections, group presentations, role-playing activities, or debates. In a generation of students infatuated with the latest and greatest social media platforms, they may expect more excitement for peer interaction in online modalities, and traditional discussion forums may quickly become a thing of the past.

Future research on asynchronous discussion forums is needed to improve on the limitations of this study and provide added validity to the results. One possible avenue for future research is

to design a true experimental study to better control for all observed differences across course sections. Ideally, the study would include multiple sections of the course taught in each semester all using the same modality. All other components of the course setup and instruction would be identical with the only variation being some sections participate in asynchronous discussion forums while others do not. This would better control for impacts on learning caused by changes over time or modality differences. A second avenue for future research would be to conduct the research experiment with coauthors across different institutions with various demographics to allow for the results to be generalize more broadly. Careful attention to detail would be needed to adequately control for differences in course components when using different instructors such as teaching and grading methods, materials, assignments, etc. Researchers should also examine the effectiveness of alternative interactive online assignments that may prove to be superior tools for learning compared to asynchronous discussion forums.

References

- Anderson, T., Liam, R., Garrison, D. R., & Archer, W. (2001). *Assessing Teaching Presence in a Computer Conferencing Context*. <https://auspace.athabasca.ca/handle/2149/725>
- Berge, Z. L. (1998). Barriers to online teaching in post-secondary institutions: Can policy changes fix it. *Online Journal of Distance Learning Administration*, 1(2), 1–22.
- Brown, R. E. (2001). The process of community-building in distance learning classes. *Journal of Asynchronous Learning Networks*, 5(2), 18–35.
- Cameron, M., Lacy, A. T., Siegel, P., Wu, J., Wilson, A., Johnson, R., Burns, R., & Wine, J. (2021). 2019–20 National Postsecondary Student Aid Study (NPSAS:20): First Look at the Impact of the Coronavirus (COVID-19) Pandemic on Undergraduate Student Enrollment, Housing, and Finances (Preliminary Data). *NCES 2021456*. <https://nces.ed.gov/pubsearch/pubsinfo.asp?pubid=2021456>
- Davies, R. S., & Mendenhall, R. (1998). *Evaluation Comparison of Online and Classroom Instruction for HEPE 129—Fitness and Lifestyle Management Course*. <https://eric.ed.gov/?id=ED427752>
- Fosnot, C. T. (2013). *Constructivism: Theory, Perspectives, and Practice, Second Edition*. Teachers College Press.
- Hawkey, K. (2003). Social Constructivism and Asynchronous Text-Based Discussion: A Case Study with Trainee Teachers. *Education and Information Technologies*, 8(2), 165–177. <https://doi.org/10.1023/A:1024558414766>
- Johnson, S. D., Aragon, S. R., Shaik, N., & Palma-Rivas, N. (1999). *Comparative Analysis of Online vs. Face-to-Face Instruction*. <https://eric.ed.gov/?id=ED448722>
- Liaw, S., & Huang, H. (2000). Enhancing Interactivity in Web-Based Instruction: A Review of the Literature. *Educational Technology*, 40(3), 41–45.
- Menchaca, M. P., & Bekele, T. A. (2008). Learner and instructor identified success factors in distance education. *Distance Education*, 29(3), 231–252. <https://doi.org/10.1080/01587910802395771>
- Moore, M. G. (1972). Learner autonomy: The second dimension of independent learning - ProQuest. *Convergence*, 5(2), 76–97.
- Moore, M. G. (1991). Editorial: Distance education theory. *American Journal of Distance Education*, 5(3), 1–6. <https://doi.org/10.1080/08923649109526758>

- Murphy. (2004). Recognising and promoting collaboration in an online asynchronous discussion. *British Journal of Educational Technology - Wiley Online Library*. <https://bera-journals.onlinelibrary.wiley.com/doi/abs/10.1111/j.0007-1013.2004.00401.x>
- Oliver, R. (1999). Exploring strategies for online teaching and learning. *Distance Education*, 20(2), 240–254. <https://doi.org/10.1080/0158791990200205>
- Picciano, A. G. (2002). Beyond student perceptions: Issues of interaction, presence, and performance in an online course. *J. Journal of Asynchronous Learning Networks*, 6(1), 21–40.
- Schutte, J. G. (1997). *Virtual Teaching in Higher Education: The New Intellectual Superhighway or Just Another Traffic Jam?* - J.G. Schutte—1996. <http://ddi.cs.uni-potsdam.de/HyFISCH/Teleteaching/VirtualTeachingSchutte.htm>
- Tuckman, B. W. (2007). The effect of motivational scaffolding on procrastinators' distance learning outcomes. *Computers & Education*, 49(2), 414–422. <https://doi.org/10.1016/j.compedu.2005.10.002>
- Wallace, R. M. (2003). Online Learning in Higher Education: A review of research on interactions among teachers and students. *Education, Communication & Information*, 3(2), 241–280. <https://doi.org/10.1080/14636310303143>
- Waltonen-Moore, S., Stuart, D., Newton, E., Oswald, R., & Varonis, E. (2006). From Virtual Strangers to a Cohesive Learning Community: The Evolution of Online Group Development in a Professional Development Course. *Journal of Technology and Teacher Education*, 14(2), 287–311.
- Zhao, Y., & Rop, S. (2001). A Critical Review of the Literature on Electronic Networks as Reflective Discourse Communities for Inservice Teachers. *Education and Information Technologies*, 6(2), 81–94. <https://doi.org/10.1023/A:1012363715212>

Appendix A: Full OLS Regression Models

Variables	Exam Score	Homework Score	Essay	Final Grade
Discussion Forum	-2.252 (4.656)	8.565 (5.776)	-5.622 (8.350)	-7.866** (3.651)
Participation Response	-2.338 (4.750)	11.18* (5.765)	-8.398 (8.338)	-8.103* (4.239)
Quizzes Required				-5.708** (2.521)
Hybrid	-4.883** (2.303)	-7.635** (3.017)	-0.169 (4.346)	-
COVID-19	3.577 (3.390)	-4.179 (3.955)	1.077 (6.401)	3.492 (3.251)
Large Lecture Hall	-7.897*** (2.187)	7.743** (3.277)	2.498 (3.627)	-3.046 (2.026)
Upperclassmen	1.605 (2.735)	-4.966 (4.221)	3.554 (4.640)	-1.476 (2.837)
G.P.A.	14.49*** (1.254)	20.01*** (1.686)	21.93*** (2.269)	17.10*** (1.354)
Business Major	3.654* (1.947)	4.390* (2.505)	6.087* (3.546)	3.592* (1.955)
Female	-5.700*** (1.521)	-2.630 (1.982)	-3.607 (2.847)	-3.657** (1.556)
Age	-0.261 (0.599)	0.765 (0.576)	0.335 (0.639)	0.124 (0.477)
Hispanic	-1.556 (1.837)	2.446 (2.402)	-0.779 (3.349)	-0.485 (1.904)
Black	-0.0736 (3.882)	-2.363 (4.446)	-3.189 (6.382)	-1.507 (4.112)
Asian	3.914* (2.271)	3.763 (3.199)	0.473 (3.590)	3.741 (2.308)
Other	5.704** (2.236)	4.219 (2.957)	1.344 (4.368)	4.322* (2.228)
Forum x Upperclassmen	1.265 (3.629)	8.739* (4.914)	0.965 (6.263)	4.775 (3.667)
Response x Upperclassmen	3.374 (3.872)	1.090 (5.507)	3.507 (6.784)	2.952 (4.216)
Constant	28.92** (12.09)	-2.354 (12.80)	8.510 (14.58)	27.16** (10.85)
Observations	378	378	378	378
R-squared	0.467	0.450	0.330	0.494

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1

Appendix B: OLS Regression Models Excluding Spring 2020 Semester

Variables	Exam Score	Homework Score	Essay	Final Grade
Discussion forum	-0.534 (3.147)	2.014 (4.700)	-4.673 (5.314)	-5.819 (3.983)
Participation Response	3.309 (3.258)	9.398** (4.138)	-3.562 (5.096)	-2.219 (5.050)
Quizzes Required				-5.625 (3.870)
Hybrid	-5.918 (4.032)	2.497 (4.427)	3.468 (6.660)	-
COVID-19	-	-	-	-
Large Lecture Hall	-7.895*** (2.205)	7.513** (3.259)	2.942 (3.653)	-3.029 (2.013)
Upperclassmen	1.712 (2.771)	-5.288 (4.279)	3.806 (4.735)	-1.595 (2.863)
G.P.A.	14.32*** (1.387)	19.82*** (1.870)	21.08*** (2.511)	16.89*** (1.498)
Business Major	3.461 (2.112)	3.904 (2.750)	5.163 (3.731)	2.859 (2.089)
Female	-5.684*** (1.732)	-4.107* (2.269)	-1.279 (3.043)	-3.973** (1.752)
Age	-0.306 (0.619)	0.795 (0.593)	0.397 (0.651)	0.121 (0.493)
Hispanic	-1.220 (2.074)	3.328 (2.683)	-2.222 (3.558)	-0.0818 (2.123)
Black	0.665 (4.430)	0.187 (5.073)	-4.683 (7.247)	-0.894 (4.672)
Asian	3.653 (2.596)	4.137 (3.649)	0.185 (3.815)	3.546 (2.659)
Other	5.543** (2.763)	5.651 (3.671)	2.468 (5.089)	4.591* (2.771)
Forum x Upperclassmen	0.291 (4.633)	4.120 (5.495)	-5.662 (7.547)	2.119 (4.474)
Response x Upperclassmen	0.167 (4.599)	0.00721 (6.423)	-1.953 (7.267)	0.228 (5.096)
Constant	30.25** (12.55)	-1.978 (13.30)	9.316 (15.25)	28.16** (11.91)
Observations	302	302	302	302
R-squared	0.460	0.432	0.324	0.480

Note: Robust standard errors in parentheses. *** p<0.01, ** p<0.05, * p<0.1