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Remotely Close: An Investigation of the Student Experience in First-Year Mathematics Courses
during the COVID-19 Pandemic

An Undergraduate Thesis
Submitted in Partial fulfillment of
University Honors Program Requirements
University of Nebraska-Lincoln

by
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Abstract

The realm of education was shaken by the onset of the COVID-19 pandemic in 2020. It had drastic effects on the way that courses were delivered to students, and the way that students were getting their education at the collegiate level. At the University of Nebraska – Lincoln, the pandemic dramatically changed the way that first-year mathematics courses looked for students. By Spring 2021, students had the opportunity to take their first-year math courses either in-person or virtually. This project sought to identify differences between the two methods of course delivery during the Spring 2021 semester, with regard to interaction with peers and instructors, resources used, and challenges to learning.

To identify these differences, a survey was distributed to students in a selection of first-year mathematics courses (MATH 101, 102, and 103) at the University, at the end of the Spring 2021 semester. The survey contained questions regarding interactions in the classroom, resources that students used while completing homework or preparing for assessments, and about the difficulty of the course and challenges that they may have faced while taking it. Responses were gathered from 37 individuals – 21 taking an in-person section of a math course, and 16 taking their math class virtually.

This project determined that students in in-person and virtual sections largely reported having a similar experience, with a few small differences. The main differences were in student-to-student interaction, which was seen more frequently in virtual courses, rather than sections offered in-person. Students largely used the same resources, and found the resources to be similarly helpful. While students faced a variety of challenges, there was overlap between the difficulties that students felt they were faced with during class, particularly when the data was

broken down on a class-by-class basis. Overall, students having a similar experience in both types of class isn't necessarily a cause for concern – it means that students are receiving a similar quality of education.

Key Words: math education, COVID-19, virtual learning

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Introduction

Institutions of higher education around the world started the Spring 2020 semester much like they had any spring semester previously. Millions of college students in the United States were on campus for classes, with more than 62% of students nationwide not being enrolled in any virtual or online courses (Fox, 2020). Within a matter of months, however, the world of education was turned upside down by the onset of the COVID-19 pandemic. By the end of the semester, 91% of faculty across the country had moved their courses to an entirely virtual delivery method (Digest of Education Statistics 2020, 2020), with many instructors never having taught an online course before. What began as an extra week of spring break for many students rapidly transformed into an educational phenomenon with repercussions that are still incredibly visible on college campuses nearly two years later.

The first-year mathematics courses at the University of Nebraska include MATH 100A (Intermediate Algebra), MATH 101 (College Algebra), MATH 102 (Trigonometry), and MATH 103 (College Algebra and Trigonometry). These courses take on a significantly different structure from other courses taught at the University, with the intent of engaging students in course material, and reinforcing concepts learned in class. Students enrolled in these courses engage in active-learning; they experience a lecture component in the course, but there is a focus on students having the opportunity to reach conclusions among groups of their peers by working problems together. Time in the classroom is supplemented by assignments that students complete outside of class time.

Prior to the onset of the COVID-19 pandemic in the spring semester of 2020, students in these courses met regularly, and often were working in classrooms equipped with round tables.

This set up helped facilitate the active-learning style of the course, by giving students ample opportunity to work together to reach solutions. These courses were also offered fully in-person, which encouraged student engagement in class, as there was not a virtual option readily available.

However, following the new guidelines regarding social distancing and classroom capacity, the way that these courses were structured changed. Students were limited in how close they could sit to each other in class, and several courses were moved into lecture halls to accommodate the number of students in the course. Several sections of each course were moved to an online format, which introduced a fresh set of differences in terms of class engagement and peer interaction. Instructors faced difficulties with maintaining student engagement, both in in-person and virtual sections of these courses, and as a result, students were faced with a number of challenges when it came to their own learning.

This project aims to examine the differences in student experiences in in-person and virtual sections of these first-year math courses, specifically during the spring semester of 2021, one year after the initial transition to online learning. To do so, a survey was conducted of students in all three of the courses mentioned above; students from both in-person and virtual sections were surveyed. The project specifically aims to explore the differences that students perceived in their engagement in class, with both their peers and instructors, while also determining whether or not students found that engagement and interaction to be a benefit to their learning. It also seeks to identify the resources that students used most frequently, and found most helpful, in both types of courses, and also hopes to establish what students found to be the most challenging about the mathematics courses that they were enrolled in.

Background

First-Year Mathematics Courses

I have had the opportunity to serve as a learning assistant in the mathematics department for two years, both prior to the pandemic and throughout it. This experience forms the basis for many of the conclusions of this project, as it gave me an opportunity to observe and learn about the following features of instruction in first-year math courses throughout the course of the pandemic. When first-year courses were able to be held in-person, social distancing guidelines in classrooms presented challenges to student interaction. Even when students were in classrooms that had the round tables from years past, they were not able to sit particularly close to one another, which discouraged students from discussing methods and solutions during class. Other sections had to be moved into lecture halls, if classrooms couldn't seat the number of students enrolled in the course, which amplified the difficulties – many seats in the lecture halls were zip-tied shut, to maintain social distancing, which made it nearly impossible for students to interact with others around them comfortably. The lecture hall setting also made it more difficult for instructors and learning assistants to move around the classroom, which creates difficulties when it comes to getting students the help they need during class time.

Learning Assistants

Learning assistants have been an integral piece of MATH 101 and MATH 103 for several years. Learning assistants are undergraduate students at the University, who are hired to assist the instructors of MATH 101 and 103 courses in facilitating the class. During class time, they move between groups of students and answer questions, while also posing questions of their own in

order to direct student learning, and facilitate discussions between classmates. This gives students in these courses another resource to turn to if they have questions during class, and takes some of the weight off of the shoulders of the instructor, especially in sections with larger numbers of students. Learning assistants are also responsible for organizing review sessions for the benchmark exams, which gives students an avenue to get help with course material and concepts prior to class assessments. Learning assistants in virtual sections of these courses played a similar role, by moving between the breakout rooms that students were placed in on Zoom. Virtual sections had one or two learning assistants available to assist the instructor in this manner.

Student Resources

The mathematics department at the University of Nebraska has made a number of resources available to students in 100-level mathematics courses. Some of these resources are incorporated into the course structure itself, while others are available to students outside of class time.

One of the key resources that students have access to in class is the instructor. The instructor, alongside the learning assistant, is not only responsible for knowing the course material, but also for being able to teach that material to students. Both the instructor and the learning assistant help to facilitate group learning by posing questions to students, which guide the direction that students take to reach conclusions. Instructors are also available outside of class during their office hours, which can be used to further assist students in their learning and understanding of course material.

The structure of the course is based around the textbook that each class uses. These textbooks are available online to students, and are free of charge, which increases accessibility for students. The textbooks have been produced by the mathematics department at the University of Nebraska, and are the backbone upon which the course is structured. The textbook not only contains the material that students learn in class and are expected to know for assessments, but also contains a wealth of examples and practice problems that mimic those on homework assignments and benchmark exams. These are available as additional exercises for students to complete, as preparation for assessments, and as a study tool throughout the course. These textbooks are used alongside a workbook that students purchase, which includes additional problems that students work on in class. These problems give students a chance to put the material that they've learned into practice, and also help guide them towards discovering the methods used in the course.

Students in MATH 100A through MATH 107 (Calculus II) also have access to the Math Resource Center. This is a tutoring center that is staffed by graduate and undergraduate counselors; they are available throughout the week in the Math Resource Center (MRC) to help students with homework questions, as well as answer questions regarding course material. This is a valuable resource, especially for students who may want material to be explained in a different way, in order to better grasp it, or for students who feel they need additional help with course material.

In Fall 2020 and Spring 2021, students also had access to lecture videos from the mathematics department that explained course concepts. These were able to serve a few purposes for students – they were a good introduction to the section, and a way for students to see the

material before coming to class, but they also were available to serve as a refresher for students as they drew closer to course assessments. These videos were something that students could go back to as needed, especially if they needed to be refreshed on specific concepts. Lecture videos were also useful if a student missed class for some reason, since they could cover the material that students may have missed.

Finally, students had the opportunity to attend benchmark exam review sessions organized by the undergraduate learning assistants for their course. These review sessions, prior to the COVID-19 pandemic, were held in-person, but following the pandemic, took place over Zoom in a synchronous, virtual format, instead. This made review sessions more accessible to students, especially those who lived off-campus, and enabled students to attend review sessions held by learning assistants other than those who assisted with their specific course section. These review sessions were intended to give students an overview of what would be covered on the exam and enable them to work through problems that were similar to those that would be seen on assessments. It also gave students an avenue to have lingering questions answered.

Survey Methods and Structure

The survey conducted contains 11 questions, which take a number of different forms. Most of the questions ask students to select where they believe they fall on a scale. These questions are intended to capture a snapshot of student beliefs and habits regarding the course. There are also two short-answer/open-response questions at the end of the survey. The purpose of these questions is to allow students an opportunity to provide more detail in their answers, and answer in a way that isn't limited to the options provided on a five-point scale. The survey was

distributed to the associate conveners of MATH 101, 102, and 103 at the end of April of the Spring 2021 semester. The associate conveners shared the link to the survey with students enrolled in each of the three courses. Most of the responses were collected during the last week of the semester, but the survey remained open until the end of the month. An overview of the survey questions is described here, but see Appendix A for the full survey.

The first few questions on the survey are intended to help split data up either by what course they were enrolled in, or whether their course was in-person or virtual. This allows data to be separated based on course number, by whether or not students were taking the course in-person or virtually, or both.

These questions are followed by a question regarding how much students felt they interacted with their peers and with their instructors in class. Students were asked to rate how much interaction they felt they had had with each of these groups of individuals on a scale of 1 to 5. This question was followed by a similar question, which asked students to describe how frequently they engaged in a dialogue or asked questions of their fellow students or instructors. This question used a scale that ranged from ‘I did not interact’ to ‘very frequent’ interaction.

The two questions that follow are closely related to each other. The first asks students to rate how frequently they used different resources that were made available to them as part of the class – instructor office hours, the workbook, etc. This question is intended to determine which resources were used most frequently, and where students were most likely to turn for help, while preparing for homework and benchmark assessments. The second question asked them to expand upon this information, by having students rate how helpful they found each of the resources mentioned in the previous question. This is not only intended to help determine which resources

students find most helpful, but also to begin examining which resources may be underutilized by students.

The next question asks students to determine how much they agree (or disagree) with a series of statements. These statements covered two distinct areas – whether or not students believed that they engaged differently with their peers in their math course than they did in other courses, and their confidence in their understanding of course material. These relate to some of the core intentions and structures of the first-year math courses, and to one of the core questions that this project answers.

The last two questions on the survey give students an opportunity to answer in more depth and detail than the rest of the survey. These short-answer questions ask students to determine what they believed were the best or most helpful resources that they utilized during the course, and to mention or explain what challenges they feel they faced while taking the class. The structure of these questions give students an opportunity to expand upon answers earlier in the survey, or to mention things that otherwise would not be contained in the survey data. The responses to these questions were sorted into categories using key words and phrases that the responses contained; more detail regarding the categorization of these responses can be found in Section III.

Research Questions

This project addresses the following research questions:

- I. *How frequently did students interact with their peers and their instructors, and did they feel like this interaction was an asset to their education?*

- II. What resources did students in first-year mathematics courses use most frequently, and which resources did students find to be the most helpful in their learning?*
- III. What were the greatest challenges to students' learning in their math courses? Was students' perception of course difficulty or their confidence in material affected by the method of course delivery?*

I. Student Engagement and Interaction

Frequency of Student Interaction

The first set of questions that this project sought to answer were in regard to how students engaged in their classes, both with their instructors and their peers. Student engagement and communication is a core element of these courses, which proved to be an obstacle throughout the COVID-19 pandemic. Prior to the pandemic, students were able to share a table with a group of their peers while working through course material; following the pandemic, however, expecting students to engage in the same ways became difficult. Some of the first questions in the survey ask students to rate, on a scale of one to five, how frequently they felt they engaged with both their fellow students and their instructors. Figure 1 (below) illustrates how frequently students who attended first-year math courses felt they interacted with other students in the class.

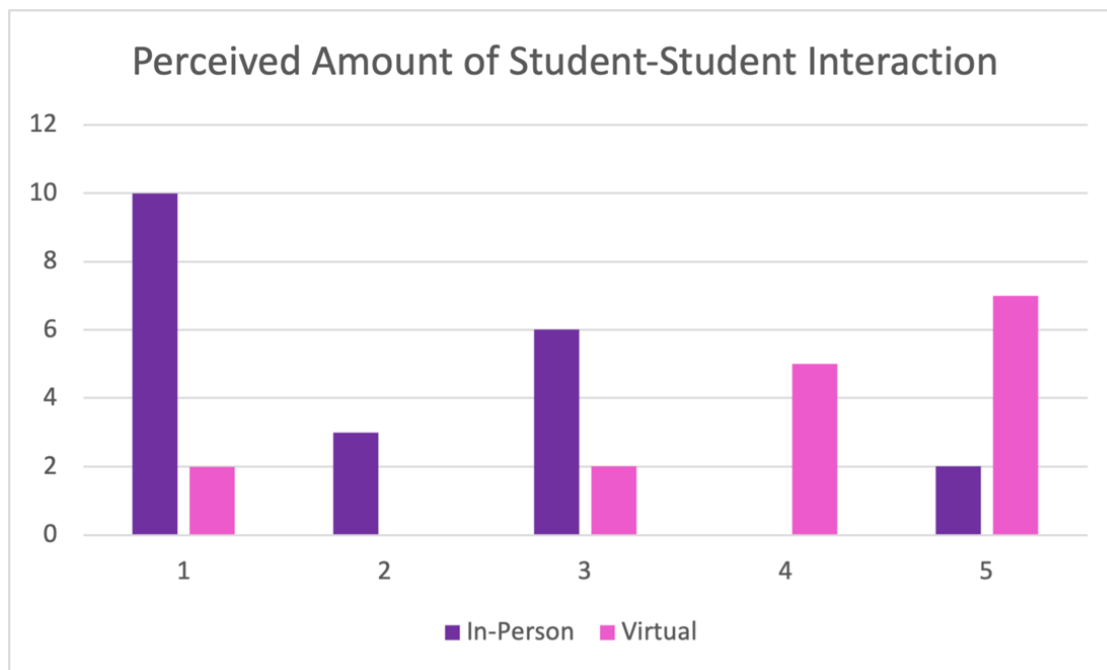


Figure 1. Number of Students Indicating Perceived Amount of Student-to-Student Interaction on a Scale of 1 (Very Little Interaction) to 5 (Frequent Interaction) in First-Year Math Courses

The figure above indicates that students in in-person sections were skewed toward little peer interaction, while students enrolled in virtual sections reported having more frequent interaction with their peers. At first glance, this data is disappointing, particularly when looking at the data for in-person sections of these courses. Ideally, students in in-person sections would be interacting more, especially following a semester of being nearly completely virtual. However, further understanding of the structure of the two methods of course delivery give some insight as to where these results came from. Virtual courses frequently had students in breakout rooms, giving them easy and accessible channels for communication. The features of these breakout rooms – for example, the Zoom whiteboard feature – allowed students to share their work with each other, making for a collaborative learning environment. While there was certainly physical distance between students – they likely weren't in the same room as each other

while they were in class – the virtual classroom that they shared overcame that distance, allowing them to cooperate on their coursework and aid each other in their learning.

Meanwhile, in in-person classrooms, students were in the same classroom, but faced physical separation all the same. Social distancing guidelines required students to maintain a distance of 6 feet from each other. This issue is of note in classrooms that were held in lecture halls – many seats in the lecture halls were zip-tied shut, to maintain social distancing. This meant that students were physically incapable of moving to sit closer together at all during class, which hampered interaction between them. Further, the large size of a lecture hall lends itself to students sitting further apart, particularly early in the semester, when they likely don't know anyone else in the class. Once a student finds a seat that they are comfortable in, it becomes their 'unassigned-assigned seat' for the class, and students are not keen on giving up their unassigned-assigned seats.

Figure 2 (below) shows data from a similar question, which regards student-to-instructor interaction, rather than interactions between students. While the difference between the in-person and the virtual sections isn't as drastic as it was for student-student interaction, it is still noticeable – two-thirds of students in in-person sections marked a 4 or a 5 on the question, while only 50% of students in virtual sections did. This appears to be consistent with the relationship of instructors to students in in-person versus virtual classroom settings. Having fewer students enrolled in the course or attending the course meetings could lead to more interactions between the instructor and the students. In-person sections tended to be smaller, due to the need for social distancing, meaning that instructors had fewer students to move between; meanwhile, virtual sections were larger, giving instructors more students to handle.

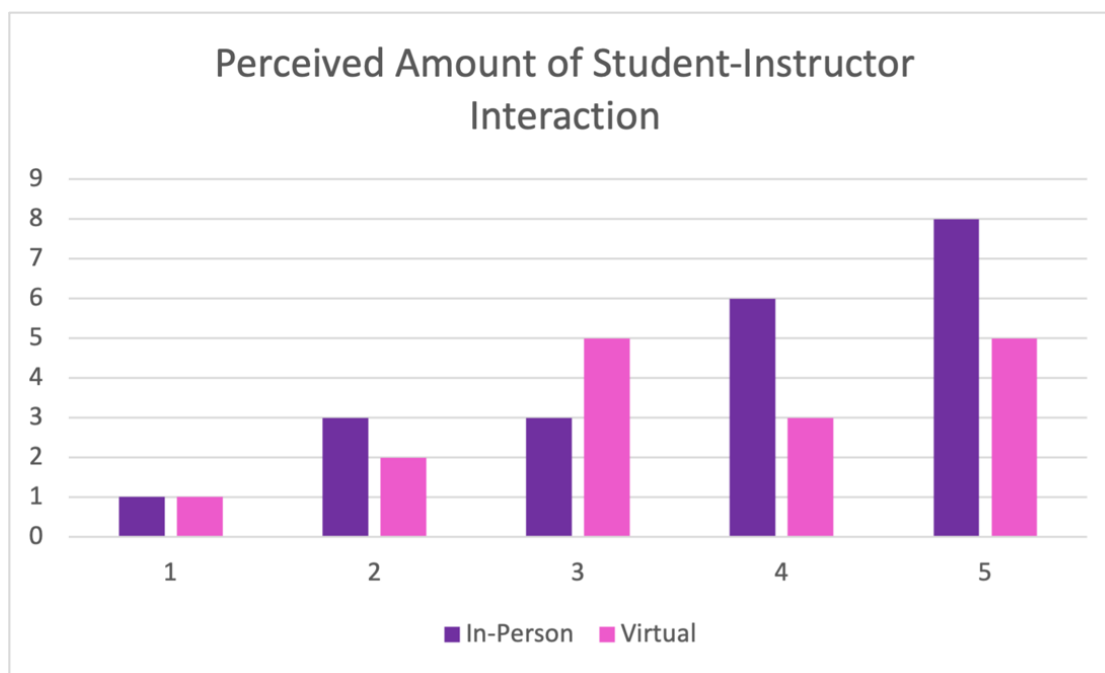


Figure 2. Perceived Amount of Student-to-Instructor Interaction in First-Year Math Courses

This is particularly noticeable in MATH 103: College Algebra and Trigonometry. There were only four sections of the course – two in-person and two virtual. The in-person sections both had less than 25 students, while the virtual sections both had over 50. The sheer volume of students in the virtual sections places additional pressure on instructors, who are now shouldering at least twice the weight of in-person instructors. If a student enrolled in an in-person section contracted COVID-19 or was required to quarantine, they attended the virtual section that met at the same time as their regular section during their quarantine, to keep up with the material. This placed additional pressure on the instructors of virtual sections, who then not only had to manage their own students, but those from other sections as well.

Difference in Student Interaction between Courses

Later questions on the survey sought to identify whether students felt that they engaged differently with their peers and instructor(s) in these mathematics courses than they did in their other classes during the Spring 2021 semester. First-year mathematics courses are taught, as discussed previously, in an active-learning format, which gives students an opportunity to fully engage in learning the material, rather than merely having it lectured at them by an instructor. As a result, this lends itself to students having different kinds of interactions with both peers and instructors. Ideally, as students become more comfortable with the active learning process, they come to see their peers and classmates as a resource. Students in these classes should be learning the material together and helping their peers to understand the material as well.

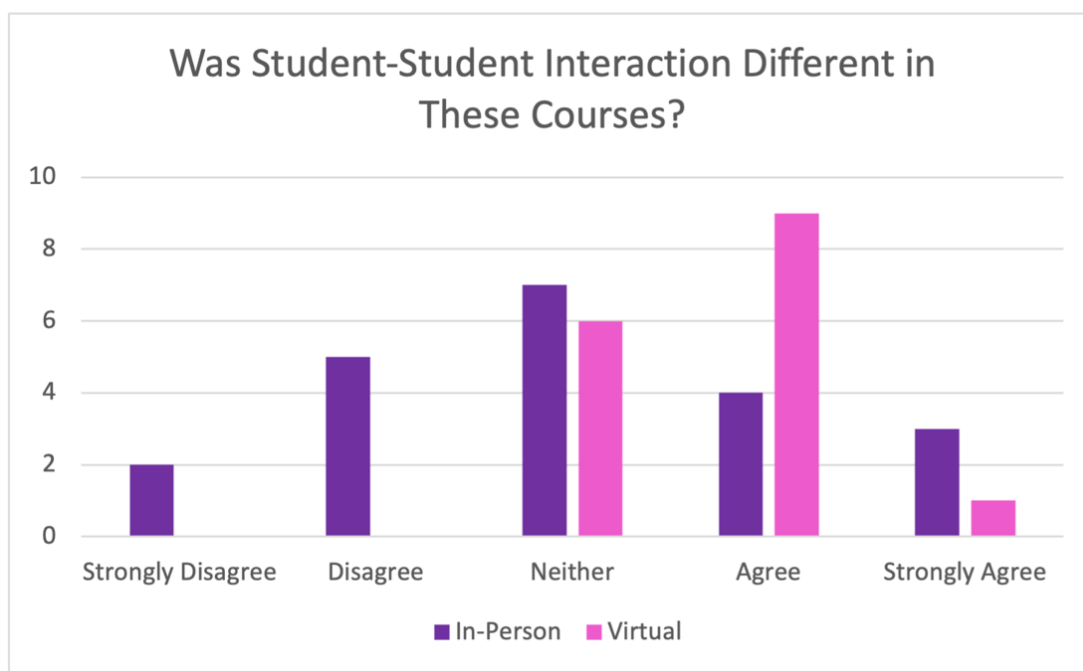


Figure 3. Perceived Difference in Student-to-Student Interaction in In-Person and Virtual First-Year Math Courses

Figure 3 (above) measures whether or not students felt that they engaged differently with their peers in their first-year math courses than the other courses in which they were enrolled during the Spring 2021 semester. It's immediately noticeable that students in virtual sections of these courses all indicated responses on the middle to right side of the scale. Most of those students indicated that they either agreed or strongly agreed with the statement. This was not the case for students in in-person sections, whose responses were distributed across the scale. Most of the responses for in-person students indicated that they disagreed, strongly disagreed, or neither agreed nor disagreed with the statement.

The general agreement of the students in virtual courses with the presented statement may be linked to how their first-year math course compares to the other classes that they were enrolled in during the spring semester. In all likelihood, most of the other courses that students were enrolled in were larger, lecture-style courses. These courses may not have allowed students to interact with their peers in class very frequently, so having the opportunity to do so in their math class likely led to the responses gathered from this question on the survey. Because these students are primarily first-year students, it's also likely that they haven't been exposed to very many small classes. The difference between these two types of classes – lecture-style vs active-learning – may be linked to the responses from students in virtual sections to this question.

When considering students in in-person sections, the responses gathered are also consistent with regard to the other courses that students are enrolled in. Even if they are in-person for their math courses, the physical distancing requirements and restrictions may have made the course feel just like another lecture. This could be the reason that students in these sections responded to the question in the way that they did. Even if these students are in smaller

class sizes, physical distancing in-person makes it difficult for students to interact with each other.

Figure 4 (below) illustrates responses to a similar question, this one regarding whether or not students felt there was a difference in the way that they interacted with their instructors in their first-year math courses, compared to the other classes they were taking. There is less of a noticeable difference with this data, with responses for students in both in-person and virtual sections following a similar pattern. Most students in both types of classes responded on the right side of the scale again, indicating that they agreed or strongly agreed that they interacted with their instructors differently. This is, as with above, likely linked to the other types of courses that students are enrolled in, and the differences between those classes and their math course. If students are enrolled in classes that are primarily taught lecture style, being able to interact with their instructors in a smaller setting – either in a Zoom breakout room, or with their instructor moving around a physical classroom to answer questions or help them – probably pushed the responses towards that end of the scale.

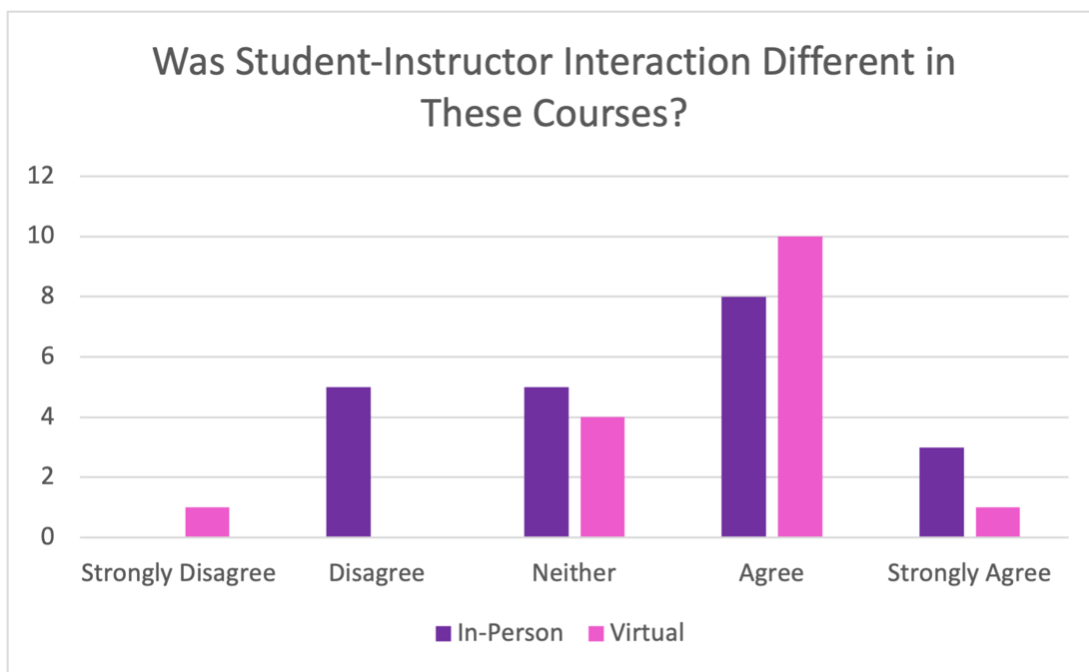


Figure 4. Perceived Difference in Student-to-Instructor Interaction in In-Person and Virtual First-Year Math Courses

Interactions and Understanding

A question later in the survey asks students to indicate their agreement with the statement “working with my peers helped me to better grasp the course material.” Figure 5 (below) illustrates the responses to that question, giving an idea of how useful students felt their interactions with their peers were an asset while they were learning the material for the course. Students in virtual courses generally agreed with the statement more than students in in-person courses, which is consistent with the questions discussed above. The students who were enrolled in virtual sections of the course felt that they had more interaction with their peers, and Figure 5 indicates that that interaction was a positive thing, for most students. Students in these sections of the first-year math courses were able to use each other as a resource during class and help

build their knowledge of the material with each other, which further enforces student confidence with course concepts.

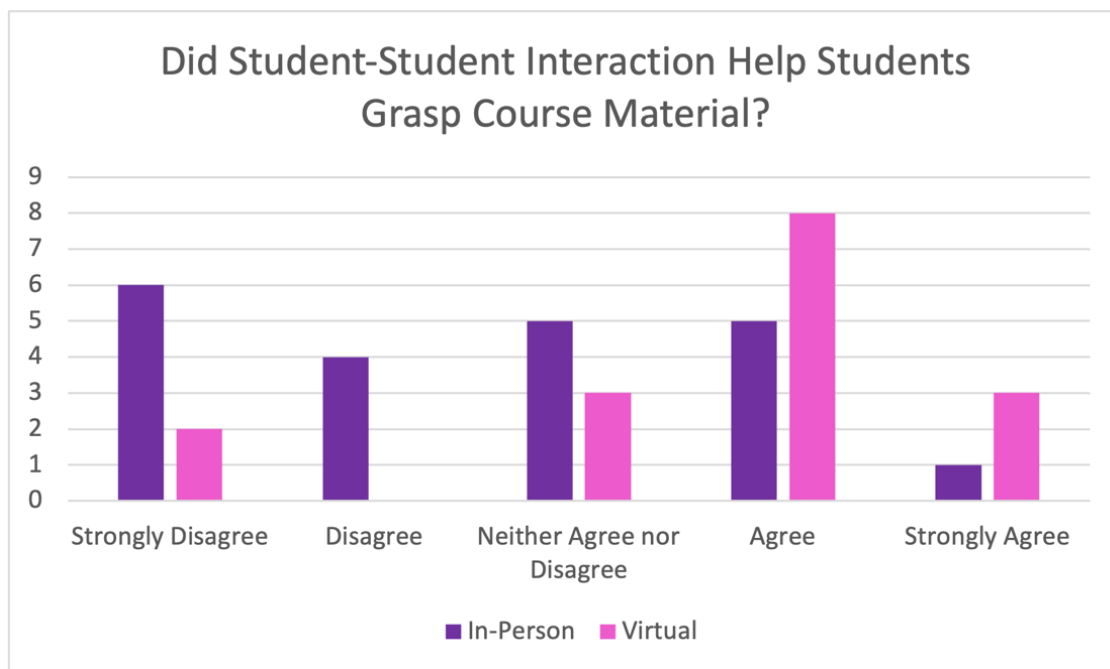


Figure 5. Student Perceptions of Whether or Not Interacting with Peers Helped Them Understand Course Material

This data is also consistent with the previous discussions regarding in-person courses. If students were not able to engage with their peers and weren't able to interact with them during class, then it's unlikely that they found student-to-student interaction to be an asset while learning the material or preparing for assessments. There are a number of students in in-person sections who indicated that student-to-student interaction did help them to grasp the course material. Even with limited opportunities for interactions between students, individuals were still able to make use of each other's knowledge while taking the course. There's certainly room for improvement, but given the circumstances, the number of students who indicated responses on

the right side of the scale is notable. This difference between in-person and virtual responses may also relate to the resources that students have access to in a virtual setting that they don't always have while taking classes in-person. For example, Zoom offers the use of a "whiteboard" function, that allows students to show their work even while in breakout rooms. They can use it to work through examples, or draw pictures/graphs if they need a visual representation to explain concepts to their students. Conversely, students in in-person sections may not have had this option, particularly if they were in a lecture hall or similar classroom for their course. Even if they had access to a whiteboard to work with their group on, having their work on display to the entire classroom of students could create hesitation in a student's willingness to make use of that resource.

II. Student Resource Use

Most Used and Most Helpful Resources

For this project, students were asked a series of questions about which resources that they used most for their course, and additionally, how helpful they found those resources to be. Students were first asked to rate how frequently they felt they made use of the resources that were made available to them, either by their instructors – office hours and benchmark assessment review sessions – or by the mathematics department – the course workbook and the math resource center. In the next question, students were then asked to expand upon this, by rating how helpful they felt each of these resources was for them.

Instructor Office Hours

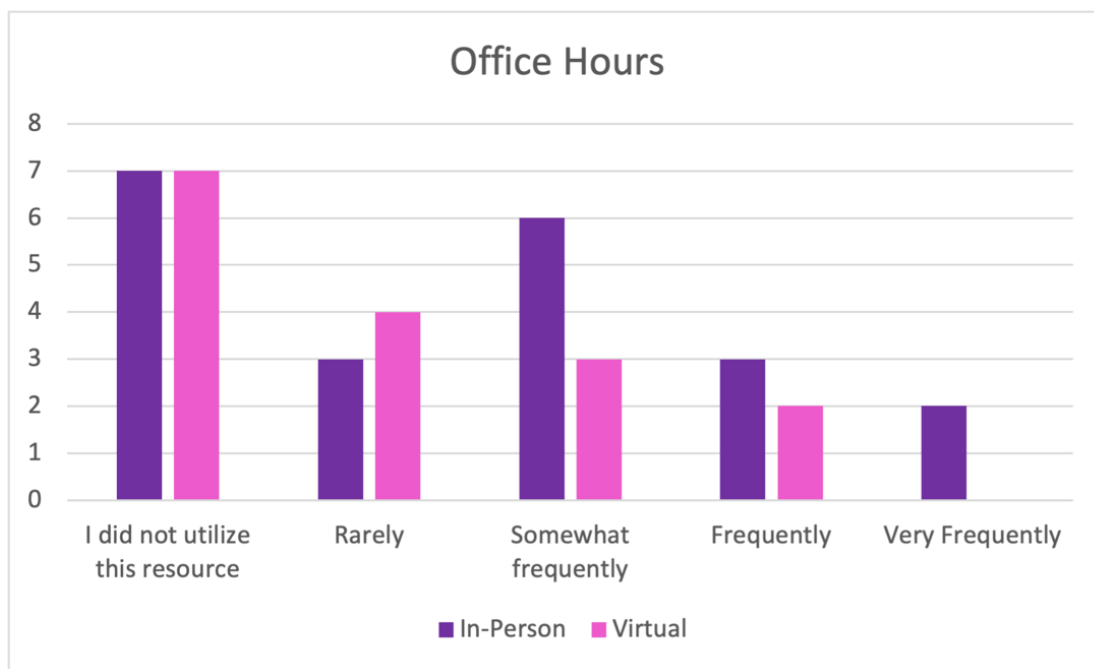


Figure 6. Frequency of Student Use of Instructor Office Hours

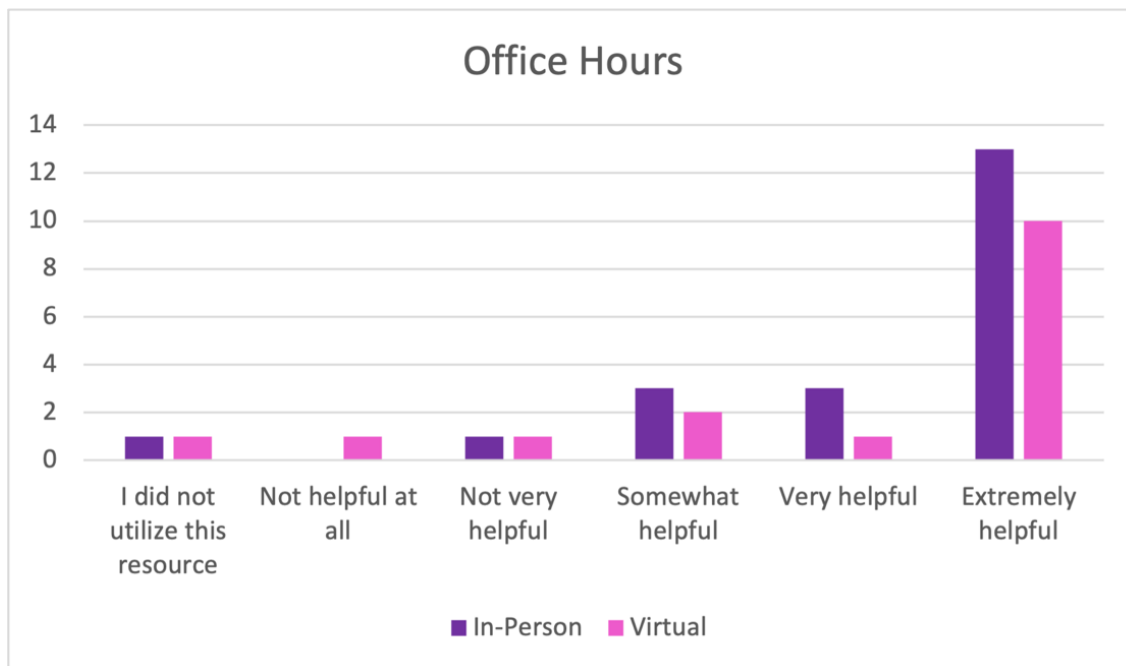


Figure 7. Reported Helpfulness of Instructor Office Hours

Figures 6 and 7 illustrate how frequently students made use of their instructor’s office hours, and how helpful they found that resource to be. It’s important to note here that the number of students who selected “I did not utilize this resource” changes drastically from Figure 6 to Figure 7 – a number of students who stated in the frequency question that they did not utilize office hours indicated a degree of helpfulness in the follow-up. This discrepancy was the most drastic with this set of data points, but shows up on all of the others for this question; all graphs henceforth have been corrected to account for these inconsistencies. This was done by adjusting some student responses. For any student that responded on the first question (Frequency of Use) with “I did not utilize this resource” for a particular resource, their response for the follow up question (Reported Helpfulness) for that same resource was adjusted to ensure that it counted toward “I did not utilize this resource”, regardless of how they initially responded.

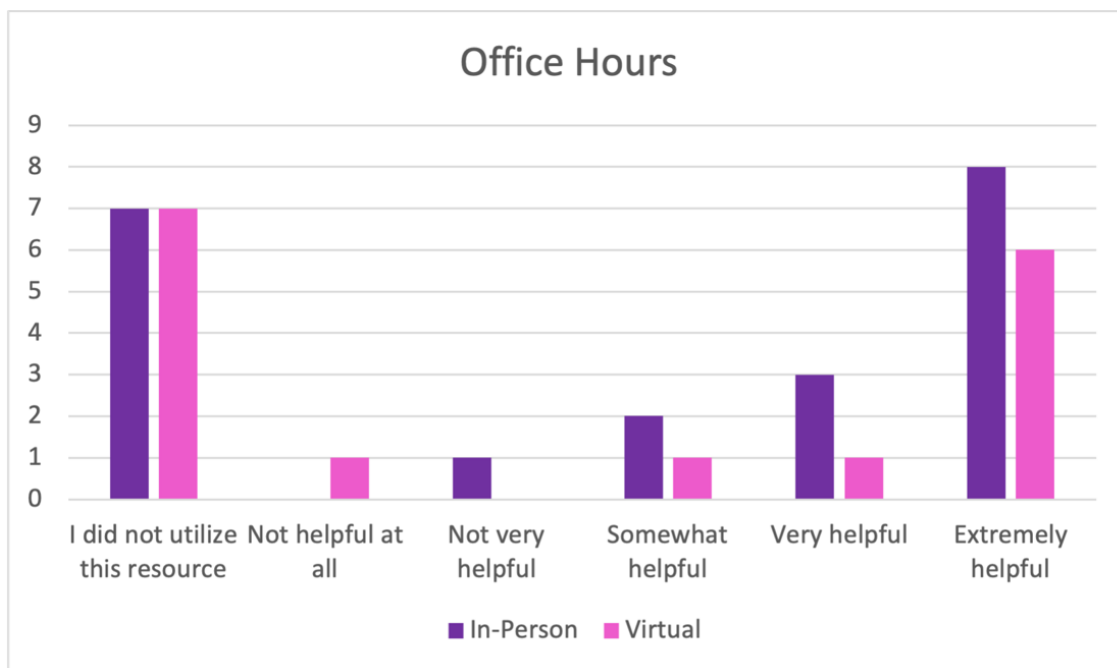


Figure 8. Reported Helpfulness of Instructor Office Hours – Corrected

Figure 8 identifies that most of the students who made use of instructor office hours found them to be either very helpful or extremely helpful. This is consistent with expectations regarding the helpfulness of office hours; they allow students to get one-on-one time with their instructor, which is used to address material and concepts that the student is struggling with. This targeted approach helps students to build confidence with material that they might not be as strong with, in a direct and straightforward manner. Further, instructors, ideally, are the most knowledgeable about the material that they are covering, and likely have experience teaching it. Students who attend office hours to get help are thus getting help that is not only targeted towards their specific needs, but is also coming from a qualified, capable source.

The patterns are similar between in-person and virtual courses with regard to office hours. Most students, regardless of how their course was being delivered, did not attend office

hours with their instructor, and if they did, it was rare. However, students who did attend consistently found the help that they received to be more helpful than not.

Frequency of student use of resources was similar across in person and virtual courses, for all of the resources discussed in this project. The figures representing these similarities can be found in Appendix B. Students largely made use of the same resources; the most-used resource was the course workbook, and the least used was the Math Resource Center. This seems consistent with student behavior – the workbook is something that students can make use of without having to leave their homes. It’s also a resource that every student has access to, without having to admit to needing help to others. When students visit the Math Resource Center, they don’t always know who they’re going to end up working with, whether or not their learning style will be compatible with the way that the counselor helping them teaches, or how busy the Center is going to be. Students may also not be available while the Math Resource Center is open, while the workbook is something that they always have access to.

Best Resources

At the end of the survey, students were asked to indicate which resources and/or individuals best supported their learning in the course, and in what way(s). This question was open-ended, which allowed students to expand upon their answers if they desired. This question also allowed students to list multiple resources that they made use of while they were taking the course. The question is intended to get a sense of the resources that students use, without limiting them to a list of resources that are provided by the university or the mathematics department. This also gave students an opportunity to give multiple responses, which allows students to

mention any and all resources that they believed to be the most helpful during their time in their course, rather than limiting them to one.

The responses in this section were coded into 10 different categories, based on some of the key words and phrases that students used in their responses. Most of these categories are fairly self-explanatory, though a few are worth some clarification. ‘Instructor’ refers to an instructor’s assistance both in and out of class time—so answering questions in class, as well as during office hours and over email. ‘Videos’ refers specifically to course videos provided by the University via the course page on the learning management system, while ‘online resources’ includes any resource online that students use, outside of those provided by instructors (for example, a YouTube video explaining a course concept, or an online graphing resource). ‘Other’ serves as a catch-all for anything else, including a student who indicated that “[their] brain” was their most helpful resource.

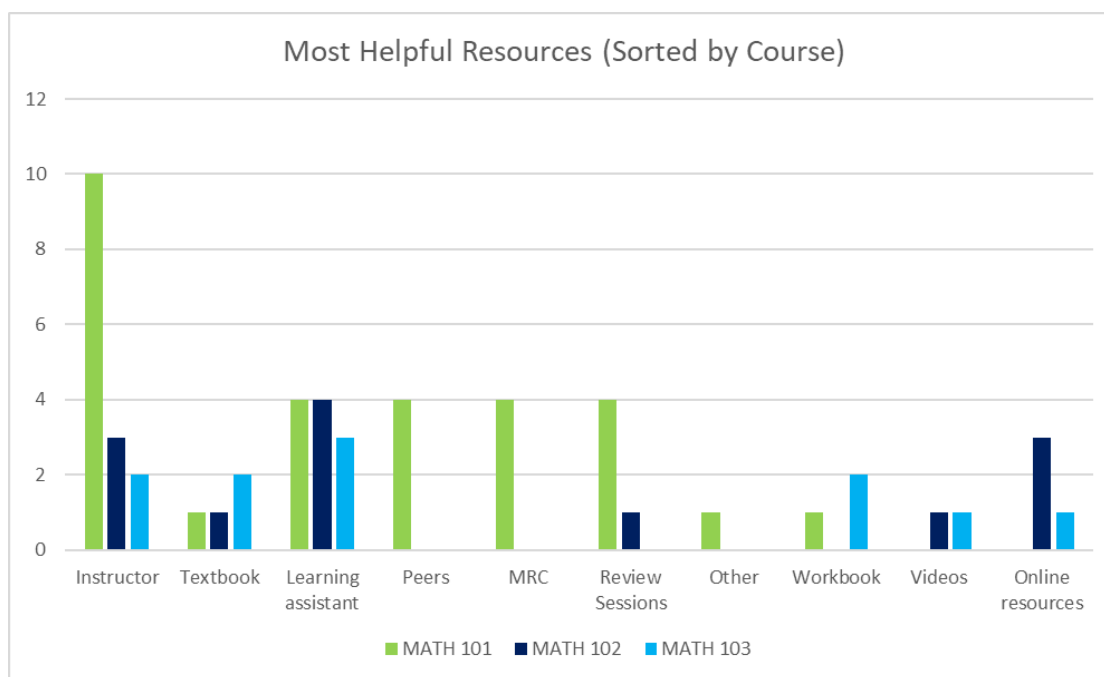


Figure 9. Most Helpful Resources in First-Year Math Courses, Sorted by Course

Figure 9 (above) indicates the resources that students listed as being the most helpful, sorted by which course they were enrolled in. It's immediately noticeable that only students in MATH 101 indicated that they felt like their peers or the Math Resource Center were particularly helpful during their time in the course. One student expanded on their response regarding the MRC, stating "the math resource center was extremely helpful...since they are available during the day throughout the majority of the week and I can just drop in without an appointment". This exemplifies a lot of the benefits of the Math Resource Center - they are incredibly accessible to students on campus and via Zoom, and don't require students to set up an appointment in order to get help.

Students identifying their peers as their most helpful resource is consistent with the number of students who felt they interacted frequently with their classmates, particularly in virtual classes. Students in virtual MATH 101 courses felt they had some of the most student-to-student interaction in their classes. If these students were having more interactions with their classmates, and if those interactions were positive, then it follows that more of those students would identify their classmates as a helpful resource for them.

Across all three courses, students also very often indicated that the instructor and the learning assistant in their courses were very helpful resources. As explained above, this makes a lot of sense – the instructor and the learning assistant are both able to offer individual feedback to students, and tailor explanations to help each student understand, rather than just painting an explanation with broad strokes that isn't necessarily going to be understood by everyone. These individuals also have some experience in the field and are able to draw on that when it comes to

explaining different subjects to students. Instructors and learning assistants may also be able to preemptively identify areas that students may struggle with, or concepts that are generally more difficult for students to understand, and adjust their explanations and instruction accordingly. This level of flexibility and customizability lends itself to instructors and learning assistants being one of the most valuable resources for students; it also indicates that making these individuals accessible to students is a key piece in student success within their courses. One student in MATH 102 specifically mentioned that the “learning assistant [was helpful] because i understood his explanations better than my professor”. This highlights one of the big benefits to having a learning assistant present to assist the instructor - different explanations of concepts are going to work better for different types of students, so having multiple perspectives or ways of explaining a problem to students in a classroom means that there are more opportunities for students to learn course concepts.

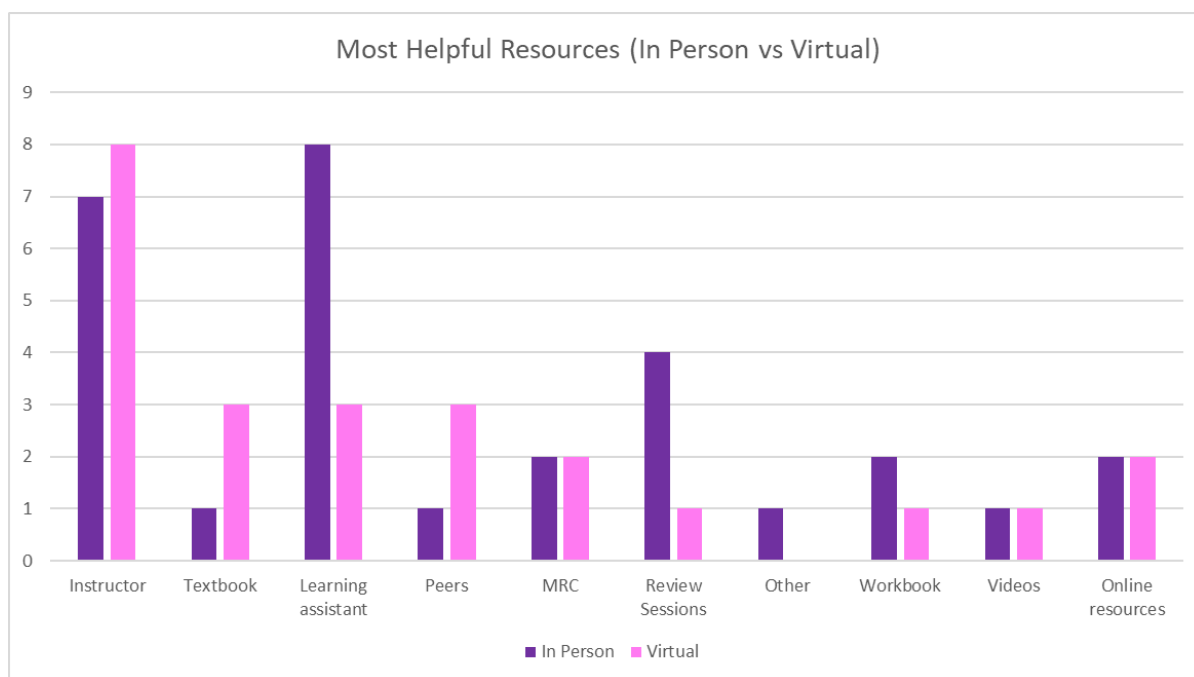


Figure 10. Most Helpful/Valuable Resources, Sorted by In-Person vs Virtual Classes

Figure 10 (above) takes the data from Figure 9, but rather than sorting it by which course students were taking, sorts by whether they were in a section that was held virtually via Zoom, or in-person on campus. The data in this figure is consistent with the data from Figure 9 – instructors and learning assistants are the resources that are identified as being the most helpful by students. There are a few areas of note, the first being the difference between students who felt their peers were a resource in in-person sections, as compared to the virtual counterparts. There is a pretty drastic difference, which circles back to the discussion under Question I, regarding student interactions with each other in in-person courses, as opposed to virtual. Because students in virtual courses had more access to their peers – meaning they weren't physically separated from them in the classroom, they were able to interact with each other on Zoom – it follows that they were able to hold more meaningful and helpful discussions. These discussions lend themselves to students being able to learn from their peers, both in and out of class.

It is also notable that students in in-person courses more frequently indicated that the review sessions for the Benchmark Assessments were a valuable resource for them. This may be related to the method of delivery itself - review sessions were held via Zoom, so if a student has been on Zoom calls all day, sometimes the last thing they want to do is join another one. Further, these review sessions were held by the learning assistants, so the difference may be related to how helpful they believed their learning assistant was. There is an indication in Figure 10 that students in in-person courses found the learning assistants to be a more valuable resource than virtual students; if students felt more connected to their learning assistant while taking in-person

classes, or felt that the learning assistant was more helpful in class, then it would follow that they would be more likely to attend that learning assistant's review sessions. It's also worth considering the difference in student-to-learning assistant ratio between in-person and virtual sections. While some virtual sections had two learning assistants working with the instructor, virtual class sizes were much larger than in-person classes, so the ratio of students-to-learning assistants was worse for all virtual courses, when compared to in-person sections. This means that learning assistants had more students that they were responsible for helping than in-person learning assistants did. this could be the reason that students in virtual sections found their learning assistants to be less of a resource than in-person students did.

III. Student Challenges and Confidence

After students identified what they felt their most valuable resources were for their math courses, they were asked to identify what challenges they faced while taking the course. This question was intentionally free response, allowing students to express whatever they felt may have impeded their success in the course, rather than requiring them to choose from a predetermined list. Responses to this question were sorted into categories based on similar responses – for example, ‘some of the concepts were challenging’ and ‘switching from algebra to trig’ both indicate students struggling to understand course material. This allowed the responses to be broken down into the following six categories: understanding material, lack of engagement, instruction, WeBWorK, personal, and motivation.

Understanding material includes responses with any mention of struggling with specific concepts or sections, as well as a general difficulty with understanding the course or mathematics. Several students in MATH 103 (College Algebra and Trigonometry) indicated difficulty transitioning from the algebra section of the class to the trigonometry section, which is not something that students in MATH 101 or MATH 102 are required to do in their course. MATH 103 covers more material than 101 or 102, making it more likely that students would, at some point, struggle to grasp a course concept.

Lack of engagement includes responses in which students identified that being unable to interact with or engage with their peers was a challenge for them. One student specifically identified that they were the “only one who communicated in [their] class” and that “most [of the students] didn’t show up to class [or] were quiet the whole time”. Whether this lack of engagement from other students was due to a lack of buy-in to the active learning system, or

something else can't be determined from this project, but it does create a barrier for this student when it comes to grasping course concepts. Comprehending course material aside, lack of interaction with peers does not create a positive classroom experience for students, and likely makes it harder for students to justify attending class.

The instruction category includes any responses that mentioned either the method of delivery of course material, or the instructors themselves, as a challenge to students. This includes things like struggling to read an instructor's handwriting or to understand the way that something is worded by an instructor or learning assistant, either in class or in a lecture video.

WeBWorK is the platform that students use to complete their homework assignments. They are given an assignment for each section covered during the class, and each assignment contains multiple questions. Students only have a limited number of attempts for each question (typically 6). This section of responses included mentions of struggling to use WeBWorK, as well as frustration with the fact that, even after all "attempts were exhausted the correct answer was still not shown". Multiple students identified that WeBWorK not showing correct answers, at any point, meant that they struggled to understand where they had gone wrong, which in turn means that they struggled to truly grasp the concepts that they were supposed to be learning. This likely translates to the assessment environment – if students don't understand the process behind a problem on homework after 6 tries, it's difficult to imagine them understanding how to do it in one attempt on a benchmark assessment.

Personal and motivations are two sections that go together. Motivation includes students mentioning that they felt like they struggled to feel inclined to attend class or complete assignments for the course. This was a common struggle for many students at the University, as

the pandemic had affected students' lives for over a year at this point. For the students in these courses who were first-year students, they were tasked with learning how to be a college student, on top of dealing with the outcomes of the pandemic. The personal section is something of a catch-all for responses that don't necessarily fit into the other categories. This includes dealing with mental health challenges, as well as struggles with time-management, and other similar responses. For example, one student cited "hating math" as a challenge in the course, a response that doesn't necessarily fall into any other category above.

Figure 11 (below) sorts responses by the sections detailed above, and also separates them by which course students were enrolled in. The number of students who indicated that understanding material was a challenge is immediately noticeable. This finding could be a result of a lack of interest in mathematics from students; it could also possibly indicate a continuation of struggling with mathematics content that has been challenging through previous years of education. Students also have the most resources available to solve that particular challenge; it's an obstacle that offers them many solutions that they can make use of, whereas other challenges might not have as many obvious solutions.

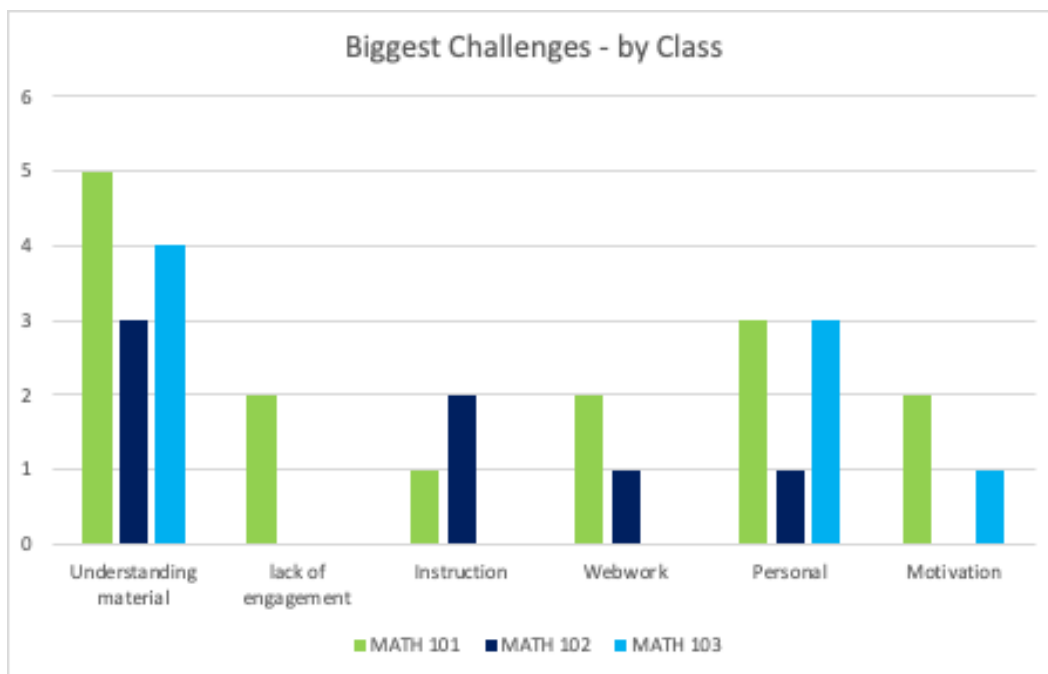


Figure 11. Biggest Challenges Perceived by Students in First-Year Math Courses

There were a decent number of students who mentioned issues regarding instruction, two of them coming from students in MATH 102. The first was in regard to the instructor’s handwriting, and stated that they “couldn’t really read the instructor’s handwriting”. The other response is a greater cause for concern, stating “everything [was a challenge], instruction by teacher was awful”. From the data gathered, it cannot be determined if this was just an issue for this individual, or if multiple students held this belief about their instructor. Either way, this would be a significant obstacle to a student’s education – either they feel that their instructor is not compatible with them as a student, or it is a genuine issue with instruction for the entire class, and neither of those are going to build a positive learning environment for the student.

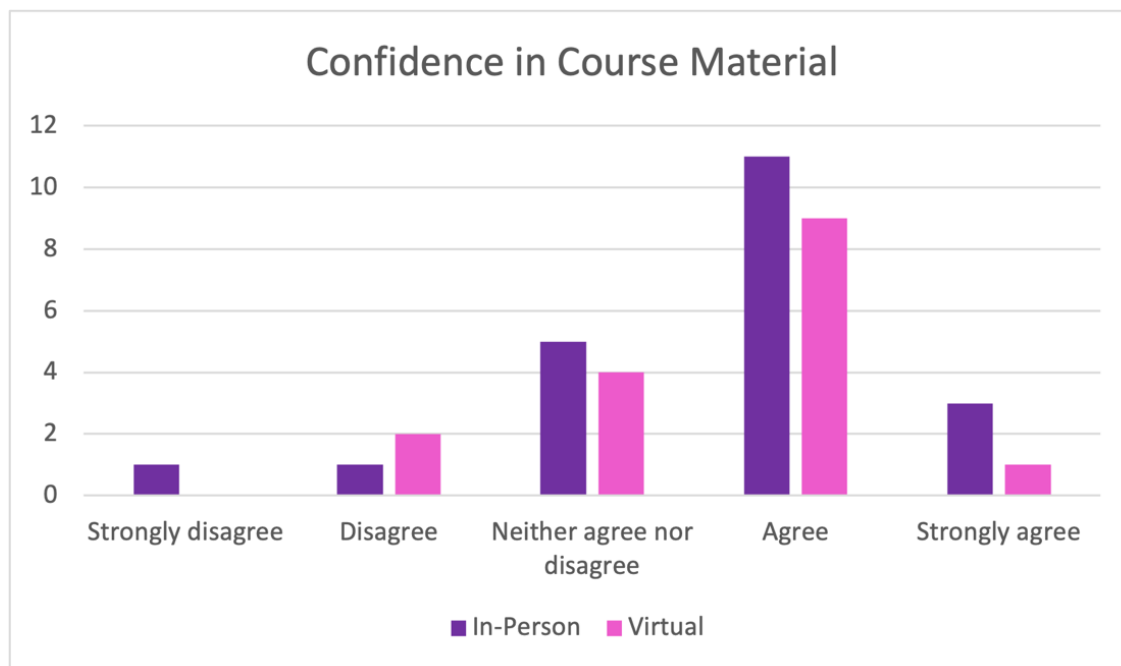


Figure 12. Student Confidence in Course Material and Concepts

Students were also asked to rate whether or not they felt confident with course material and concepts. This data is displayed in Figure 12 (above), while Figure 13 (below) indicates whether or not students felt the course material was difficult to grasp or understand. Figure 12 identifies that most students felt more confident than not in the course material, which is a positive thing. Students generally understood the material, or at least understood it enough to complete their assessments and pass the course that they were taking. The patterns of the data are similar between virtual and in-person classes; students should be getting the same education out of both methods of course delivery, and the fact that their perceived confidence is similar indicates that they are getting a similar quality out of their math courses.

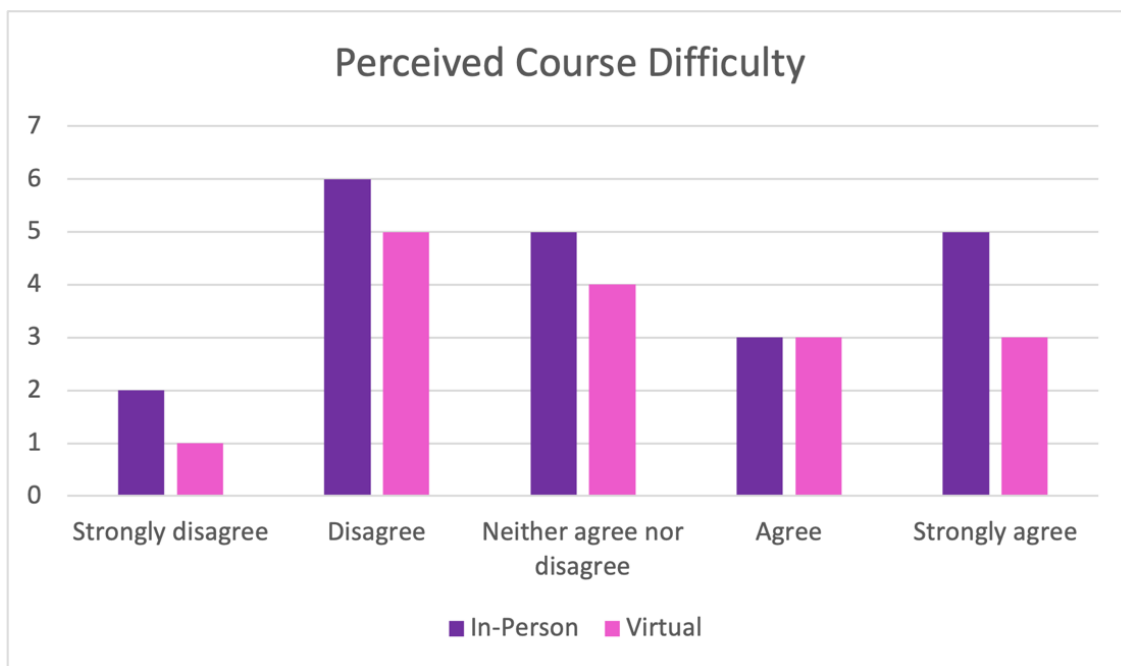


Figure 13. Student Agreement with the Statement “I found the material covered in this course to be difficult”

Responses from students regarding the difficulty of the course are pretty varied. That is to be expected; depending on a student’s mathematical background and overall attitudes towards math, they may have vastly differing opinions on whether or not the material of a mathematics course is difficult. This also depends on a student’s learning style, and how that matches up with the way that their instructor teaches, as well as the other things happening in the student’s personal life while they are taking the class. Figure 14 (below) separates this data by the specific courses that students were enrolled in, to get an idea of which classes students believed were more difficult, compared to others. This figure represents these numbers as percentages, to account for the fact that there were about twice as many students enrolled in MATH 101 than in either of the other two courses.

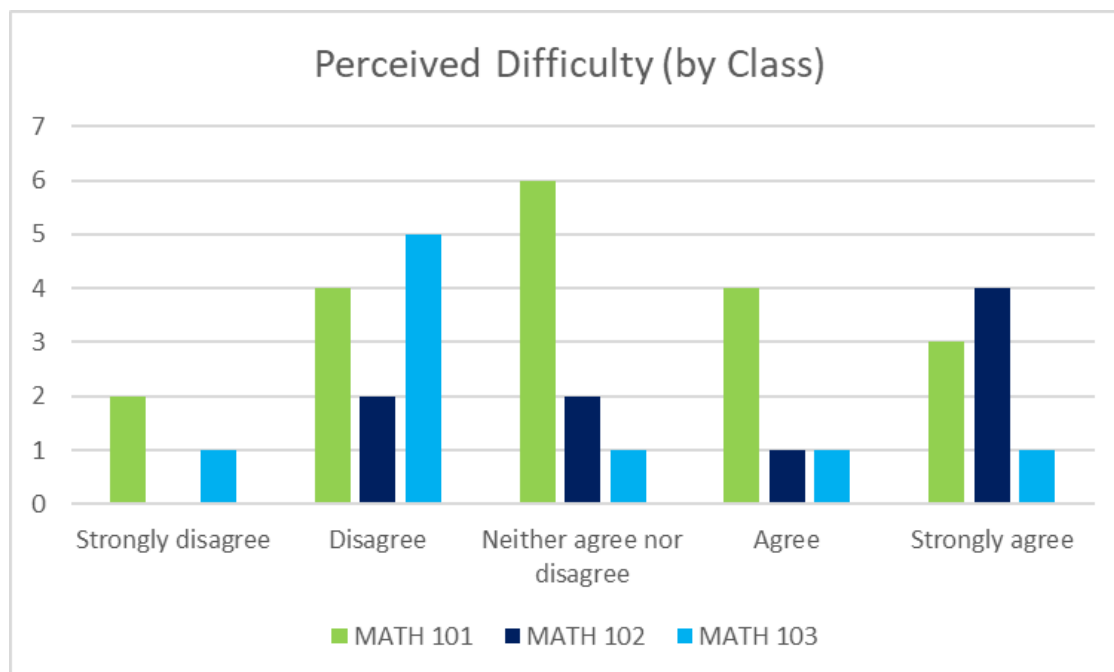


Figure 14. Student Agreement with the Statement "I found the material covered in this course to be difficult", Sorted by Class

The two notable jumps on this graph are with MATH 103 and the volume of students who indicated that they disagreed that the course material was difficult, and with MATH 102, which had many students indicate that they strongly agreed that the material was challenging. This may have something to do with how often each of these courses meets during the week. MATH 103 is a five-credit hour class, and meets every day, Monday through Friday, while MATH 102 is only a two-credit hour class, and thus meets only twice a week. Students in MATH 103 spend three times as much time in their math course as students in MATH 102; exposure to material is an important factor in education, and thus, spending less time being around the material could link to an increased perception of course difficulty.

Project Limitations

There are a number of limitations that came along with this project and the way that the survey was conducted. The first is the timing of the survey; students in these mathematics courses are also completing end-of-semester course evaluations in all of their classes at the end of the semester, and they are also asked to complete a survey run by the mathematics department. The math department survey is significantly longer than this one, though most students do have the opportunity to earn extra credit or extra points in their math class as an incentive to complete it. Sometimes, the last thing that a student wants to do is give more feedback on a class that they've already been giving feedback on. Further, it's not always reasonable to expect students to remember what exactly their best resources have been throughout the entirety of a semester long course by the time they get to the end of the semester.

The other limitation regards the lack of incentive that this survey offered to students. This creates a limit on what types of students who are going to complete the survey. Realistically, the students who completed the survey were either students who saw the email and decided to complete the survey then and there, or students who were genuinely very interested, who decided to not complete the survey immediately, but came back to it later because of that interest. It's completely reasonable to expect that students may not want to complete yet another survey, especially if that survey is being run by someone that they've never met before, who can't offer them any incentive for doing so.

Finally, the survey was limited in its number of responses. There were over 450 students enrolled across MATH 101, 102, and 103 during the Spring 2021 semester, and only 37 of those

students responded to the survey. It's not a very big number, but it is about 8% of the students in those classes, which is more than acceptable for a survey that offers no incentive to students.

Conclusion

It's no secret that the COVID-19 pandemic has had lasting impacts on the world of education. Students around the world had their version of academic 'normal' disrupted, as classes were moved online, universities were closed, and everyday life was interrupted. Many of the changes caused by the initial onset of the pandemic are still prevalent today, particularly at institutions of higher education. At the University of Nebraska – Lincoln, first-year math courses were offered as both virtual and in-person courses during the Spring 2021 semester. This project sought to look at the differences between these two distinct methods of course delivery, by answering three core questions:

- I. *How frequently did students interact with their peers and their instructors, and did they feel like this interaction was an asset to their education?*
- II. *What resources did students in first-year mathematics courses use most frequently, and which resources did students find to be the most helpful in their learning?*
- III. *What were the greatest challenges to students' learning in their math courses? Was students' perception of course difficulty or their confidence in material affected by the method of course delivery?*

Most notably, students in virtual sections of MATH 101, 102, and 103 felt that they were engaging with their peers more than students in the in-person sections. This is likely due to the physical distancing restrictions in in-person classrooms, that weren't present in virtual sections. Students taking these courses virtually were able to engage with their classmates via Zoom breakout rooms, while students in in-person courses were unable to sit close to each other in the classroom.

Students across both methods of course delivery made use of the same resources.

Generally, these resources were just as helpful for online students as they were for in-person students. The resources that students found to be the most valuable were the course instructors and the learning assistants; this is likely due to the fact that both of these resources allow students to get individualized feedback and help and allows them to ask specific questions about what they're struggling with. Students in virtual courses also found their peers to be very helpful, which is likely due to the fact that they had ample opportunity to interact with each other, and many resources at their disposal within Zoom.

Students faced a variety of challenges in their classes, regardless of how that class was delivered. The most prevalent of these challenges was a difficulty understanding the course material. There is also an indication within the data that students in MATH 102 had difficulties with course instruction, but the cause for this difficulty cannot be ascertained by this project. Students in MATH 102 more frequently indicated that they found the course material to be difficult, compared to students in other courses; this may be due to the difference in time spent in the classroom, between MATH 102 and the other two courses offered. Overall, patterns in responses regarding student confidence were similar across both virtual and in-person courses, which indicates that students were receiving a similar quality of education in both types of classes. The goal of the structure of the virtual courses was to mimic the way that these classes were offered prior to the pandemic, so the fact that students in both courses experienced similar outcomes is a positive thing.

The findings of this project give an indication of what students find to be most helpful while enrolled in first-year mathematics courses, when taking those courses both in the virtual

setting, and in-person. This information allows instructors an avenue to make resources available that are going to be an asset to students, and also to examine which resources may be underappreciated or underutilized.

This project also emphasizes one of the core benefits of holding these courses in the virtual setting, namely students having the freedom to interact with each other during class without having to worry about physical distancing. Virtual sections of these classes make the active-learning structure of these mathematics classes accessible to students even if they aren't living on campus while taking the class and encourages participation from a variety of students. The overarching goal of the first-year mathematics courses is to engage students in their education in a group-learning environment. This goal has been challenged by the limitations created by the COVID-19 pandemic during the past two years, particularly in the first year following Spring of 2020. Students and instructors alike have fought to overcome these limitations and challenges, in their academic lives, as well as in their lives outside of the classroom. While there were some differences between the experiences of students in in-person and virtual sections of these first-year mathematics courses during the Spring 2021 semester, students generally walked away from the course feeling confident in their understanding of the course material, having been supported by valuable and important resources while they were enrolled in these classes.

Appendix

A. Student Experience Questionnaire

Student participation in this survey will provide information about how to best support students in these courses in the future, so all feedback is valued. Responses to this questionnaire may be incorporated into my thesis, but responses will always be kept completely anonymous.

1. What is your NUID?
2. Please select the first-year math course that you were enrolled in during the Spring 2021 semester
 - a. Math 101
 - b. Math 102
 - c. Math 103
3. Was your first-year math course in-person or held virtually via Zoom?
 - a. In-Person
 - b. Held virtually via Zoom
4. Approximately how frequently did you attend class, either virtually or in-person, on a scale of 0 (I did not attend class) to 5 (I attended 100% of classes)?
5. On a scale of 1 (very little interaction) to 5 (frequent interaction):
 - a. How much student-to-student interaction did you have in class?
 - b. How much student-to-instructor interaction did you have in class?

Students responded to the following question on a five-point scale: 1. I did not ask questions/engage in a dialogue with this individual, 2. Rarely, 3. Somewhat frequently, 4. Frequently, 5. Very frequently

6. How often did you ask questions or engage in a dialogue with the following individuals during class?
 - a. Instructor
 - b. Learning assistant

Students responded to the following question on a five-point scale: 1. I did not utilize this resource, 2. Rarely, 3. Somewhat frequently, 4. Frequently, 5. Very frequently

7. How often did you utilize the following resources while completing homework assignments or preparing for assessments?
 - a. Instructor (during office hours)
 - b. Workbook
 - c. Math Resource Center
 - d. Benchmark Review Sessions

Students responded to the following question on a six-point scale: 1. Not helpful at all, 2. Not very helpful, 3. Somewhat helpful, 4. Very helpful, 5. Extremely helpful, 6. I did not utilize this resource

8. How helpful were the following resources in supporting your success in the course?
 - a. Instructor

- b. Learning assistant
- c. Workbook
- d. Math Resource Center
- e. Benchmark Review Sessions

Students responded to the following question on a five-point scale: 1. Strongly disagree, 2. Disagree, 3. Neither agree nor disagree, 4. Agree, 5. Strongly agree

9. Please rate how strongly you agree or disagree with the following statements:
- a. I engage with my peers differently in this class than in my other classes
 - b. I engage with my instructor differently in this class than in other classes
 - c. I found the material covered in this course to be difficult
 - d. I feel confident in my understanding of the course material
 - e. Working with my peers helped me to better grasp the course material.

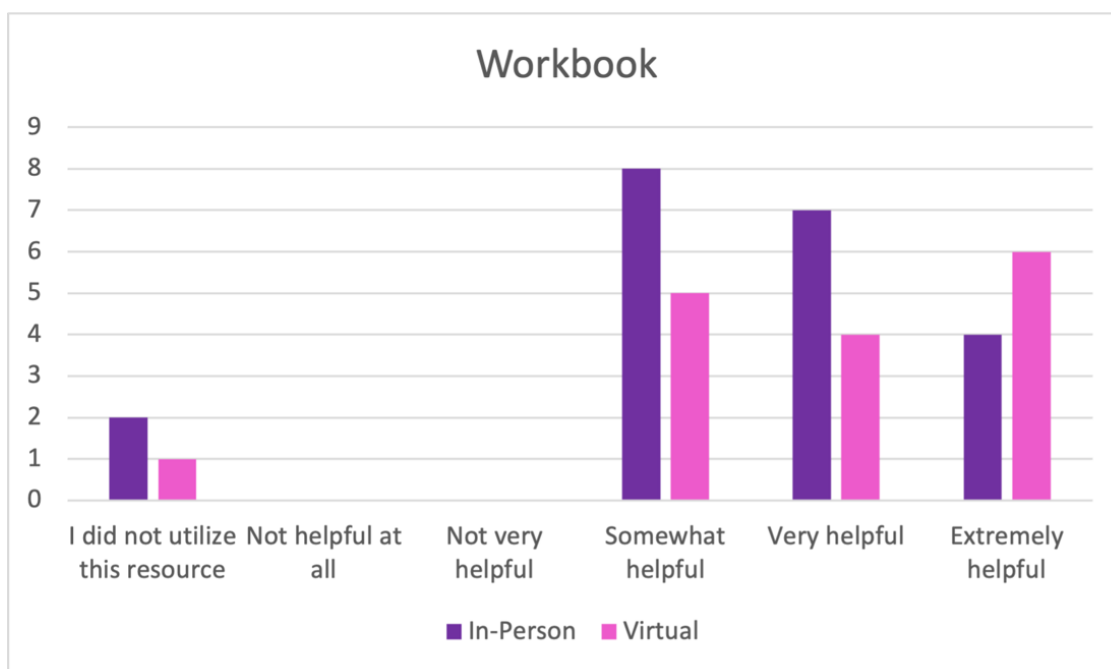
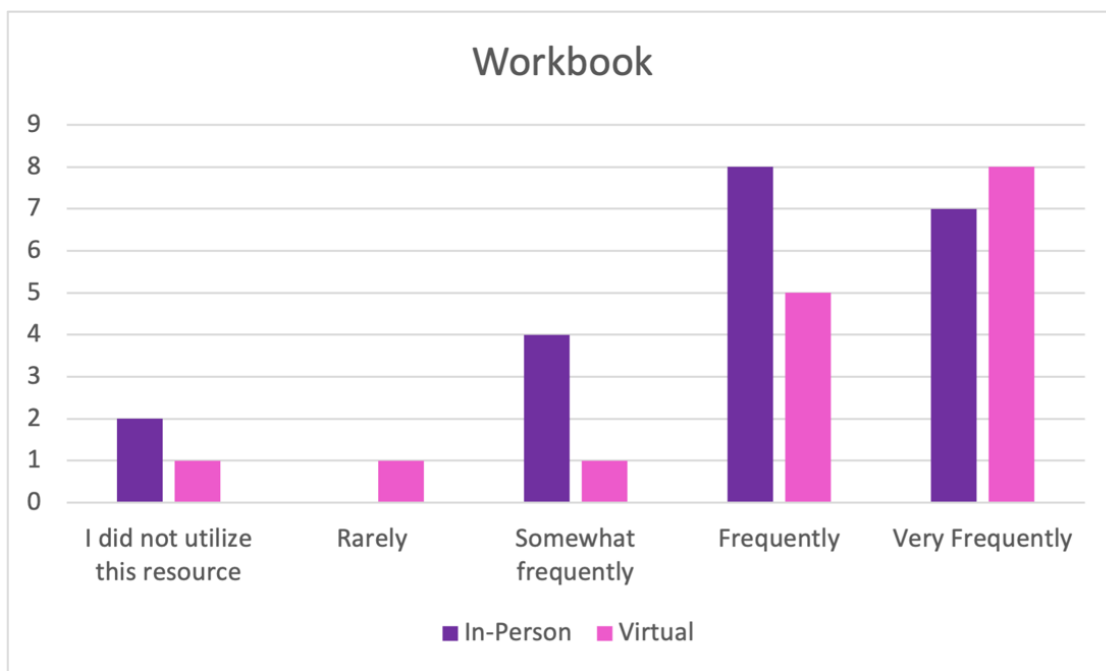
10. What resources or individuals best supported your understanding of the course material?

How so?

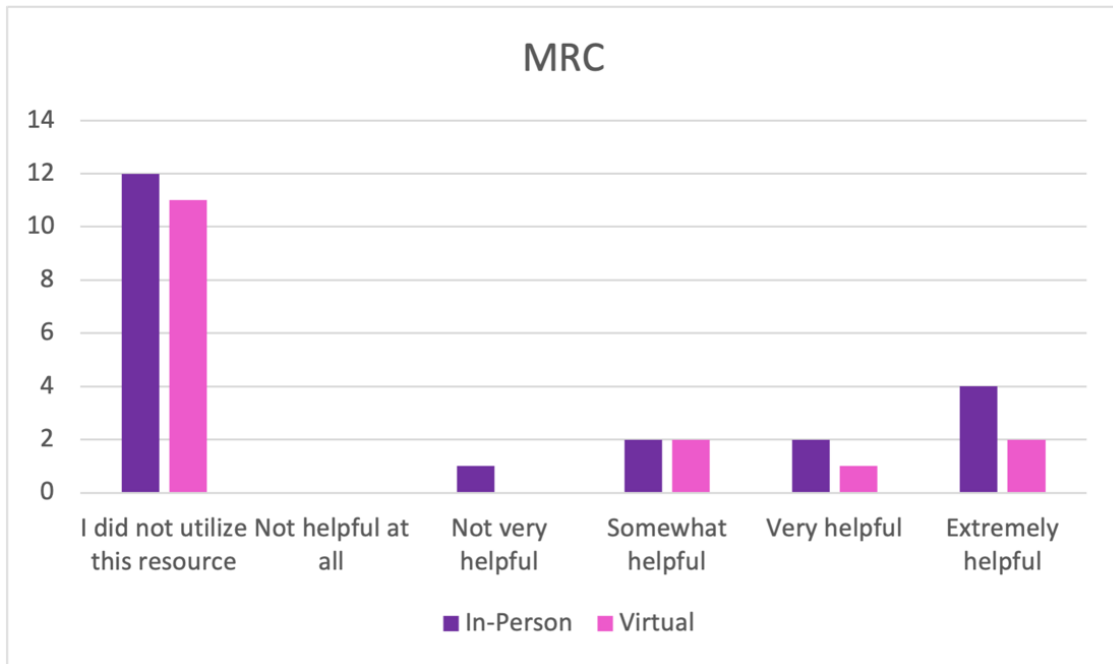
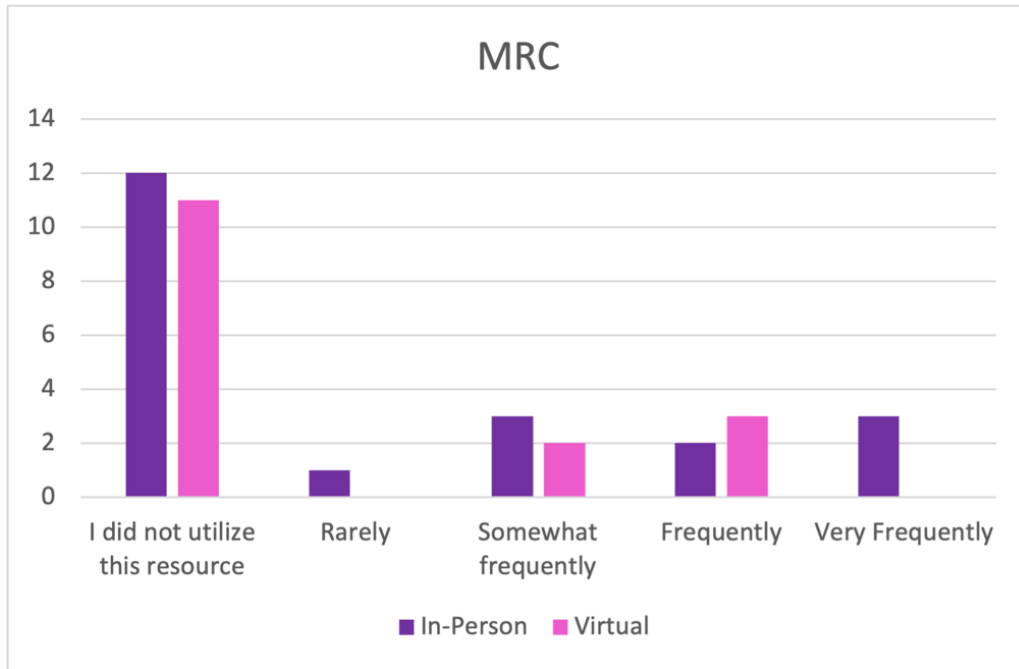
11. What challenges did you face in this course?

B. Figures from Section II

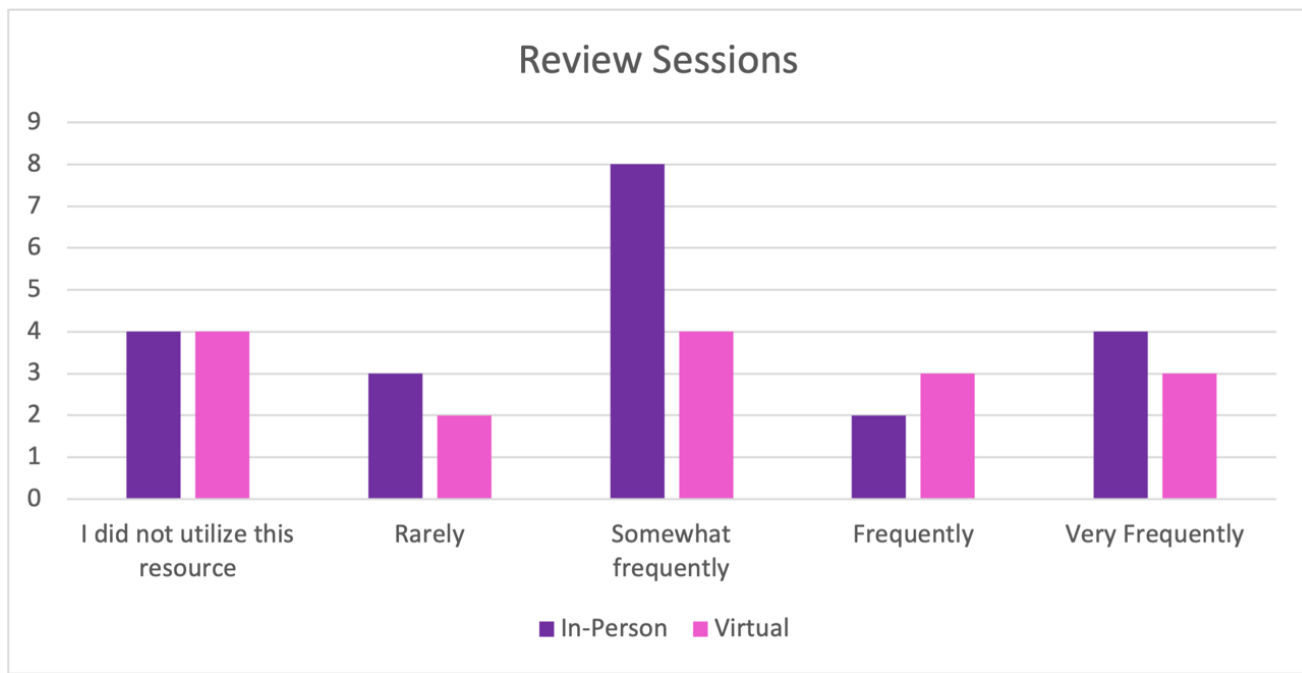
How often did students utilize the course workbook while completing homework assignments or preparing for assessments, and how helpful was the course workbook?

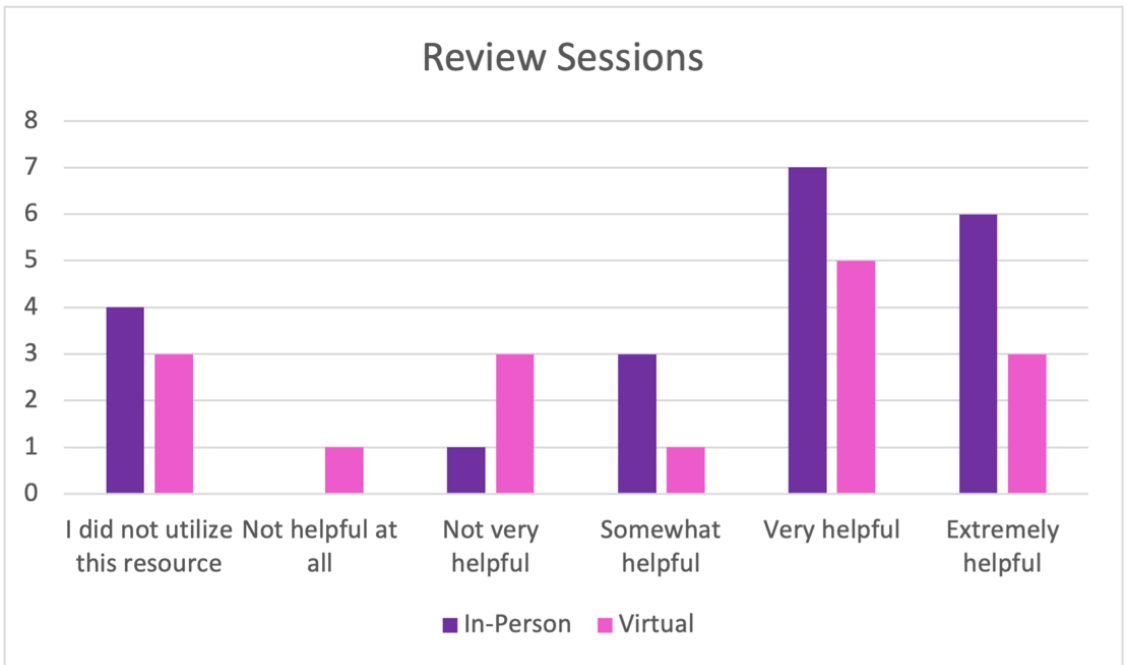


How often did students utilize the Math Resource Center while completing homework assignments or preparing for assessments, and how helpful was the Math Resource Center?



How often did students utilize the Benchmark Assessment Review Sessions while completing homework assignments or preparing for assessments, and how helpful were the Review Sessions?





C. Responses from Questions 10 and 11

Question 10. What resources or individuals best supported your understanding of the course material? How so?

In-Person Courses

MATH 101

- My brain. And realizing if I want to succeed this year I was gonna need to teach myself more than ever.
- I utilized two students that were also in the class. We were able to talk through homework and ask each other questions after quizzes
- I think the fact that I was able to really learn this independently but still had my professor there to ask questions and to explain things in lecture really helped
- The fact that it was in person kept me more engaged and helped me learn material better. The instructor and LA were helpful.
- Workbook and review sessions were extremely helpful, the workbook is probably the best resource
- The teacher the math resource center and the learning assistant they just always helped when I need it
- Supplemental instruction/review during zoom allowed me more time to focus on specific concepts
- I did not use any resources
- The professor because he taught it.

- The professor really helped me understand the course material. The professor was able to breakdown and explain the problems or situations that I had trouble with, and it overall helped me understand the course.
- The math resource center was extremely helpful for me since they are available during the day throughout the majority of the week and I can just drop in without an appointment. The learning assistant for my class was also extremely helpful because he would explain the concept in a extremely comprehensible way.
- Instructor, and the assistance. They were very helpful in Class, answering questions!

MATH 102

- My Instructor and learning assistant did a really great job at breaking things down and making things much more understandable.
- learning assistant because i understood his explanations better than my professor
- Book, notes, slides, of cours going to class.
- The vidoes were suppose to watch, and the TA answered my questions in a way I understood for the most part.
- YouTube, review sessions, and online sources helped

MATH 103

- Youtube and going to class helped a lot
- The learning assistant, instructor, and workbook. It helped to work on problems in the workbook and ask questions if needed.

- The Learning Assistant. She was able to explain things that I didn't understand in a easy-to-understand way.
- N/A

Virtual Courses

MATH 101

- Professor
- online book, instructor, learning assistant, peers
- Instructor and peers
- Both the instructor and learning assistant were very helpful and always took their time in explaining problems I struggles with.
- Instructor. Groups. MRC
- Instructor and MRC
- The review sessions helped the most. The sessions allowed me time to go through the homework and have questions to bring to the review session.

MATH 102

- Desmos helped solve problems
- N/A
- The instructor was very helpful. Resources such as desmos were useful in understanding the subject.

- The professor and teaching assistant were most helpful in this course. The zoom meetings were also very helpful! They always responded quickly to my questions when I emailed them and helped me a lot in class whenever I asked a question. They explained everything to me very well.

MATH 103

- The math book and videos. It helped me figure out what to do.
- The workbook because it was digestible and had immediate problems to do once material was learned
- The zoom sessions were honestly the best help to me and being able to go back and rewatch the lectures
- The textbook, because it provided the explanations and resources I needed when I needed them.
- TA and the Instructor help me understand this course

Question 11. What challenges did you face in this course?

In-Person Courses

MATH 101

- Zero peer to peer interaction. I was the only one who communicated in my class. I am not sure how the other students in this class even passed the first 2 test. Most of them either didn't show up to class. And when they did show they were quiet the whole time and

didn't ask a single question. Also at the end of the year the professor said I was the only one who went to his office hours the whole semester.

- Understanding the material covered in class. I found I learned more on the weekly videos we had to do before the quizzes
- I think the biggest challenge that I had is staying focused on the work that I needed to do in this class because it was an easier class so I spent less time on this class compared to my more challenging classes.
- Some concepts were hard for me to grasp but the resources helped me.
- Not completing all the webwork assignments
- Probably preparation for the final
- Mental health
- None
- Working with webwork was a pain.
- The only challenge that I had in the class was to make sure that I had the deadline. I have missed some deadlines before, so I just had to make sure that I meet those deadlines.
- Problem solving questions. Also, there were a lot of questions in the workbook that weren't taught in the lecture videos.
- The 1 point reading questions before the class, I would forget to do a lot of them.

MATH 102

- Some of the concepts were challenging to me since I'm not the best at math.
- I didn't do so hot on the first benchmark, but I finished with an A

- My grade is not good at all. I tried my best.
- The material is very hard, especially because personally I feel math should be taught face-to-face so you can interact instead of watching a video and being lost and unable to ask questions.
- Couldn't really read the instructor's handwriting, hard to develop true concepts of the material.

MATH 103

- Understanding course material
- There was a lot of material to cover but the course overall went smoothly
- Trigonometry. I have never learned trig before, so it was hard at the beginning to grasp the information, but the instructor and Learning Assistant were very helpful.
- Switching from algebra to trig

Virtual Courses

MATH 101

- The math part
- None
- Understanding the material
- Understanding certain problems correct answers in webwork.
- Staying motivated after halfway through semester
- Lack of interaction

- The program used for homework. The hints were vague and if all attempts were exhausted the correct answer was still not shown. This left me still confused on the material.

MATH 102

- Understanding variations
- Everything, instruction by teacher was awful
- Being virtual was sometimes challenging.
- Webwork was hard to use because if I got something wrong it wouldn't show me the correct answer so I couldn't learn from my mistakes. It was also hard to keep up with some of the homework along with going to class and studying on my own.

MATH 103

- If I'm being honest, waking up early enough to attend class. I'm not a morning person.
- Hating math
- Learning how to be a college student
- It was more so stressful, because I didn't really attend class nor did I ask very many questions; it resulted in a build up of stress anxiety when approaching exams. Although I was confident in the fact that I understood the content which would also affect my decision on whether or not to go to class. It is basically a loop.
- Nothing

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