Factors Influencing Learning in Asynchronous Online Community College Gateway Math: Insights From Instructors and Students

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Soo Hyun Son

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Son, Soo, H | Nhv2as@virginia.edu | [redacted]

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Dr. Jennifer Pease
Chair
Curriculum, Instruction & Special Education
Education and Human Development, University of Virginia
Signed by: Dr. Jennifer Pease
4E91A72AAB4D43B...
3/25/2025

Co-Chair
(If applicable.)

Dr. Wintre Foxworth Johnson
Committee Member
Curriculum, Instruction & Special Education
Education and Human Development, University of Virginia
Signed by: Dr. Wintre Foxworth Johnson
3/25/2025

Dr. Christine Trinter
Committee Member
Other
Other
Institute for Educational Initiatives
University of Notre Dame
Signed by: Dr. Christine Trinter
3/25/2025

Committee Member

Committee Member

Committee Member

Committee Member

Abstract

Advisor: Jennifer Pease

Gateway math courses in community colleges often hinder degree completion due to high failure rates (Attewell et al., 2006; Koch & Gardner, 2018). The asynchronous online modality exacerbates these challenges, requiring greater self-regulation and showing lower success rates than face-to-face classes (Xu & Jaggars, 2011; Bird et al., 2020). Despite Northern Valley Community College's (NVCC) efforts to improve completion rates in first-year gateway math courses, success rates in the asynchronous sections of MTH 161 Precalculus I (NOL MTH 161) remain persistently low, with high rates of unsuccessful outcomes (NVCC Office of Strategic Insights, 2022). Students and instructors identified supporting factors such as clear course organization, proactive instructor communication, and opportunities for peer resource sharing alongside challenges, including gaps in preparedness, misaligned assessments, limited peer collaboration, and insufficient instructor presence. Addressing these issues through targeted interventions and strategic course design is critical to improving student success. Findings provide actionable insights for enhancing outcomes in NOL MTH 161 and supporting broader institutional efforts to improve retention and success in online community college education.

Keywords: gateway math, community college education, asynchronous education

DEDICATION

To community college educators who make a difference every day,
and to students who persevere in pursuit of their dreams.

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Chapter 1 Introduction

Distance education has transformed how students access and engage with learning in higher education, whether synchronously or asynchronously. Technology allows for the delivery of instruction and learning experiences to students who are separated from the instructor and campus, facilitating support and substantive interactions to promote learning (NCES, 2023). In Fall 2021, over 60% of all undergraduate students in the United States higher education institutions were enrolled in at least one distance education course (NCES, 2023). Asynchronous online learning has further revolutionized access to higher education, particularly for students who face time constraints that prevent them from attending college in the traditional in-person format or from attending lectures delivered synchronously.

Asynchronous learning refers to students accessing instructional materials such as recorded lectures or reading textbooks and presentation slides at their own pace and engaging with peers and instructors through various online platforms, such as discussion forums, emails, and multimedia recordings. These completely online classes are available 24/7, offering flexible learning opportunities that enable students to pursue their education while managing work, childcare, and other commitments.

The percentage of undergraduate students at degree-granting postsecondary institutions who participated exclusively in distance education courses shows that students enrolled in 2-year institutions like public community colleges are more than twice as likely to be enrolled in online courses compared to students attending four-year institutions (NCES, 2021). The convenience of asynchronous online classes has made them increasingly popular among community college students, many of whom are working full-time or part-time jobs. Nationwide, community colleges are experiencing a significant shift towards online education, with a substantial portion of their student bodies now enrolled in online courses. According to the Community College Research Center at Columbia University, over 65% of community college students, about 3 million students, took at least one online course in Fall 2021 (CCRC, 2024).

This trend has only accelerated during the COVID-19 pandemic, as more students recognize the benefits of online learning. Data indicates that almost 40% of community college students are enrolled entirely online, with an additional 30% taking some online courses (IPEDS, 2022). However, research indicates that community college students may not perform as well in fully online asynchronous courses compared to face-to-face or synchronous online courses (Jaggars & Xu, 2010; Xu & Jaggars, 2011; Xu & Xu, 2019). Students in online courses were found to be less likely to complete their courses and less likely to attain a degree or transfer to a four-year institution (Xu & Jaggars, 2011).

For example, a study of the Virginia Community College System revealed that online course completion rates were 13 percentage points lower than face-to-face completion rates (Jaggars & Xu, 2010). Additionally, among students taking online courses, completion rates for math courses were the lowest, nearly 19 percentage points lower than those for in-person courses (Jaggars & Xu, 2010). While online education has increased access to higher education, online courses have been associated with negative outcomes on student course performance, persistence, and other measures.

While institutions like Northern Valley Community College (NVCC)[1] in Virginia had existing infrastructure for online education, the pandemic's impact has led to a surge in online enrollment. Community college students, often low-income and balancing multiple responsibilities, have embraced online courses for their flexibility and convenience (Weissman,

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[1] Northern Valley Community College (NVCC) is a pseudonym, used at the request of the institution. Information from the school’s guiding documents is not cited to preserve the anonymity of the institution.

2023). The overwhelming majority of students (94%) report satisfaction with their online courses, with nearly 60% expressing a desire to take more online courses in the future (Seaman & Seaman, 2023). However, research suggests that the outcomes of students in entirely online courses are not always positive. Studies indicate challenges and concerns with the effectiveness of online courses, particularly at community colleges (Barshay, 2015), raising important questions about how best to support students in online environments and optimize their learning outcomes.

Problem of Practice

Northern Valley Community College (NVCC) has identified a key objective in its 2023-2026 strategic plan: to increase the timely completion of gateway math courses for students in their first year. Successful completion of a gateway course is defined as achieving a grade of C or higher. Despite NVCC's ongoing efforts over the past eight years, the success rate in the STEM gateway math course, MTH 161 Precalculus I, has remained between 20% and 41% (NVCC Office of Strategic Insights, 2022). This persistent challenge directly hinders NVCC's progress toward its strategic goal. Higher rates of unsuccessful outcomes (Grades D, F, or W) in asynchronous online MTH 161 sections offered through NVCC Online (NOL) highlight the critical need for applied research to address challenges in this course format. This need is particularly critical as NVCC focuses on expanding NOL to replace synchronous virtual online courses and anticipates an increase in asynchronous online course enrollment.

Purpose of the Study

This section outlines the main goal of the research. The purpose of this Capstone project was to explore the factors influencing students' reaction (satisfaction, engagement, relevance), mathematical learning (including knowledge, attitude, confidence, and commitment), changes in study habits and behaviors, and overall course outcomes in the NOL MTH 161 Precalculus I course offered at NVCC Online through an exploratory case study. By investigating the perceptions and experiences of both students and instructors, the research identified key elements that supported or hindered student learning within an asynchronous online gateway math class. Through these insights, the study supported the mission and strategic goals of NVCC by refining and enhancing curriculum and instructional strategies tailored specifically for asynchronous online gateway math courses. This project assessed and improved the overall effectiveness of the course, enhanced the college's online programs, and addressed barriers in MTH 161 that may have impacted retention, progression into higher-level courses, degree attainment, or transfer to four-year institutions.

Research Questions

The study addressed the following research questions:

- What factors do instructors perceive as supporting or hindering student learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?
- What factors do students perceive as supporting or hindering their learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

Rationale

Despite the increasing prevalence of online learning in higher education, particularly in community colleges, there remains a significant gap in research on the specific factors that impact student learning, engagement, satisfaction, and outcomes in asynchronous online gateway math courses. Since gateway math courses serve as a critical entry point to degree programs and higher education pathways, understanding these factors is crucial for providing timely support in online learning environments. By addressing this gap in research, this study provided valuable insights that can inform the design of more effective online math courses, enhance student support services, and ultimately improve student outcomes. This research has the potential to benefit not only students but also educators, institutions, and policymakers seeking to optimize online learning environments and promote student success in mathematics education.

Theoretical Framework

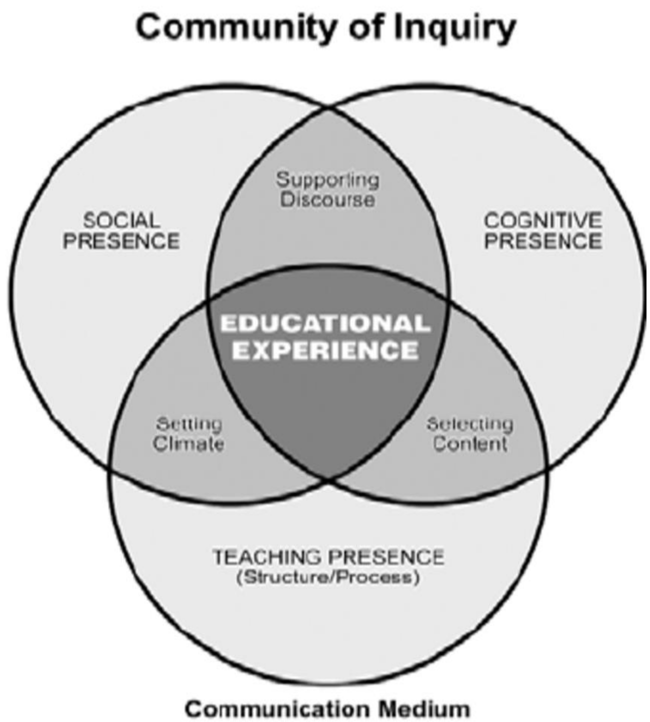
This study explores the perceptions and experiences of students and teachers in the asynchronous online math course, MTH 161 Precalculus I at NVCC. To investigate the factors that impact online learning more effectively, Garrison's Community of Inquiry (CoI) Model, a theory of e-learning, is chosen as the primary theoretical framework. The CoI Model, developed by Garrison, Anderson, and Archer (2000), offers a comprehensive framework for creating online learning environments that promote critical thinking, inquiry, and discourse among students and instructors. Comprising three key elements—cognitive presence, social presence, and teaching presence—the CoI framework has been instrumental in providing insights and methodological approaches for studying asynchronous online learning.

- ***Cognitive Presence*** relates to the development of meaningful learning through critical discourse and reflection. It involves learners' ability to construct and confirm meaning through reflection.
- ***Social Presence*** focuses on the ability of learners to project themselves socially and emotionally, fostering a sense of community.
- ***Teaching presence*** involves the design and facilitation of educational experiences, including instructional design and feedback.

The theory posits that the interactions among these elements create an environment conducive to collaborative learning, enabling students to engage deeply and meaningfully in online courses.

Figure 1.1

Community of Inquiry Model (Garrison, Anderson, & Archer, 2000)



Three elements of Garrison's CoI framework align with this study exploring factors impacting student learning in the asynchronous online gateway math course, NOL MTH 161. The framework's emphasis on cognitive presence correlates with the need to comprehend how students engage with course content and critically reflect on concepts in an asynchronous online setting. The focus on social presence aligns with the significance of fostering interactions and a sense of community among students and instructors in an online environment. Lastly, the component of teaching presence is pertinent to studying how instructional design and facilitation influence student learning outcomes in NOL MTH 161. By applying the CoI framework to this tudy, I gained insights into these factors and their impact on student success in the course.

Conceptual Framework

The Community of Inquiry (CoI) Model provides a valuable framework for understanding how students learn in online classrooms. However, it is not specific to this problem of practice study and does not address all the elements underlying NOL MTH 161. To address this, the conceptual framework for this study integrates Kirkpatrick's Four Levels of Evaluation with the CoI Model to specifically assess the factors influencing student learning in the asynchronous online gateway math course, NOL MTH 161 (see Figure 1.1 and Table 1).

Kirkpatrick's model is used as a guiding framework to identify initial areas of interest, such as reaction, learning, behavior, and results, within the context of the CoI Model. This integration provides a structured lens through which to explore the factors influencing student learning. By combining these frameworks, the study aims to provide a comprehensive evaluation of the course's effectiveness, considering both the theoretical aspects of online learning environments and practical evaluation metrics. Integration helps to systematically explore students' reactions, learning experiences, behavioral changes, and overall outcomes, thereby offering a holistic view of the factors that support or hinder student success.

The conceptual framework illustrates my orientation to the problem of practice, as well as the elements that inform the research questions. The following subsections explain the relationships between the elements of my conceptual framework, while also connecting them to the CoI model and the literature on evidence-based gateway math practice (see Chapter 2).

Table 1.1

Integration of Kirkpatrick's Four Levels of Evaluation with CoI Model

CoI Key Elements	Description	Kirkpatrick's Level	Components
Cognitive Presence	Development of meaningful learning through critical discourse and reflection.	Level 2: Learning	• Knowledge: Constructing and confirming meaning through reflection and discourse. Skills: The practical application of learned concepts • Attitude: Disposition towards content and motivation. • Confidence: Self-assurance in understanding and application. • Commitment: Dedication to continuous engagement.
Social Presence	Ability of learners to project themselves socially and emotionally, fostering a sense of community.	Level 1: Reaction	• Engagement: Interaction and sense of community among students. • Satisfaction: Comfort and connectedness in the online environment.
Teaching Presence	Design and facilitation of educational experiences, including instructional design and feedback.	Level 1: Reaction Level 3: Behavior Level 4: Results	• Relevance: Alignment of course content with students' goals. • Learning applications: Applying concepts to solve problems. • Changes in Study Habits: Influence of instructional design on study strategies. • Academic Performance: Achievement of learning outcomes. • Course Completion: Effectiveness of instructional design and facilitation. • Progression to Higher-Level Courses and Career Readiness: Preparation for future academic and career endeavors.

Note. The table illustrates the integration of Kirkpatrick's Four Levels of Evaluation within the Community of Inquiry (CoI) model framework to assess the effectiveness of the NOL MTH 161 Precalculus I course. Each CoI element is evaluated using the relevant components of Kirkpatrick's model to provide a comprehensive analysis of student learning and success.

Figure 1.2

Conceptual Framework

Gateway Math Online Classroom

Novice Online Learners
- New to an online learning environment
- Overwhelmed by transition

Asynchronous Online Math Instructor
- Pedagogical expertise in online teaching
- Engaging and interactive learning experiences

Jumping in the unknown water of Online Math

Instructor is to facilitate learning and support

Teaching Presence on Initial Reaction

Selected Contents to Maximize Cognitive Presence
Relevance of content → Interest in learning → Engagement with materials

Accelerated Remediation and Just-in-Time Support and Feedback
Satisfaction with support → Confidence boost → Feeling of being supported

Connecting to Resources
Easy access to resources → Comfort with available resources →Increased motivation

Where learning and application happens

Cognitive Presence Pool on Learning and Behavior Change

Triggered Event
Knowledge acquisition and Initial engagement with content

Exploration
Skills development, Attitude towards learning, and Confidence in exploring new concepts

Integration
Application of knowledge, Changes in study habits, Integration of new information with existing knowledge

Resolution
Problem-solving, Decision-making based on learned content, Demonstrating understanding through assessment

Where learning solidifies through collaboration

Social Presence Playground

Group cohesion
- Sense of community
- Satisfaction with peer interactions

Open Communication
- Engagement in discussion
- Comfort in sharing ideas

Positive Feedback
- Perceived support from peers and instructors, increased motivation,
- Development of confidence, and Positive attitude toward learning

Collaboration
- Development of collaborative, problem-solving, and interpersonal communication skills
- Application of collaborative skills and teamwork-based problem-solving

15 Weeks Later: Looking Forward to Another Online class!

Course Outcomes: Empowered Students and Success

Empowered Students Outcome
Ownership of learning, Satisfaction with learning experience, Confidence in skills and knowledge, Preparedness for future courses and real-world applications

Student Success
Improved academic performance, Course completion rates, Progression to higher-level courses, Engagement and retention in online learning, Overall satisfaction with the course

Novice Online Learners in Gateway Math Classroom

At NVCC, 75% of students are recent high school graduates under 25 years old. Consequently, students in gateway math courses are typically first-year students who do not fit the typical profile of adult learners. Novice online learners in the gateway math classroom are students who are new to the online learning environment and may be unfamiliar with the expectations and tools used in online courses. Gateway students are often in their first semester or first year in college and are learning the academic expectations of college-level courses. These students may feel overwhelmed by the transition to online learning and may require additional support to navigate the course successfully. Adaptation strategies for these students include providing clear instructions, orientation materials, and ongoing support throughout the course.

Asynchronous Online Math Instructor with Pedagogical Expertise

The asynchronous online math instructor plays a crucial role in supporting novice learners and facilitating a positive learning experience in asynchronous online gateway math classrooms. The instructor should have pedagogical expertise in online teaching methods and be willing to create engaging and interactive learning experiences. It’s important for instructors to understand that teaching an online class is different from teaching in-person classes, and they should be prepared to adapt their teaching strategies accordingly. Instructors should complete training courses to teach online classes. Strategies for maximizing the instructor’s pedagogical expertise may vary but should include providing training and resources for online teaching, fostering a supportive online learning community, and offering timely feedback to students.

Teaching Presence on Initial Reaction (Level 1)

Teaching presence in the gateway online math course is crucial for establishing a supportive and meaningful learning atmosphere. This includes selecting course content that optimizes cognitive presence, utilizing accelerated remediation strategies, and providing timely support and feedback to students. Additionally, facilitating access to supplementary resources such as tutoring services, various college offices for first-year student support, or instructor-generated online study materials enriches the students' learning journey. Effective teaching presence cultivates cognitive presence among students, fostering critical thinking, problem-solving, and a profound understanding of mathematical concepts. Instructors also play a crucial role in preparing students for meaningful social learning, enhancing learning outcomes through collaboration.

Cognitive Presence Pool of Learning and Behavior Change

The Cognitive Presence Pool of Learning is the structured and guided learning environment in the online math class where students engage in meaningful activities that promote critical thinking, problem-solving, and a deep understanding of mathematical concepts. This pool represents where learning happens (Levels 2 & 3). Triggered events initiate knowledge acquisition and initial engagement with content. Exploration involves skills development, attitude towards learning, and confidence in exploring new concepts. Integration focuses on the application of knowledge, changes in study habits, and integration of new information with existing knowledge. Resolution encompasses problem-solving, decision-making based on learned content, and demonstrating understanding through assessment.

Social Presence Playground

The Social Presence Playground is where learning solidifies through collaboration (Levels 1, 2, & 3). It serves as a dynamic space where students engage with peers to enhance their understanding of mathematical concepts. Group cohesion fosters a sense of community and satisfaction with peer interactions. Open communication encourages engagement in discussions and comfort in sharing ideas. Positive feedback, encompassing Levels 1 and 2, includes perceived support from peers and instructors, increased motivation, development of confidence, and positive attitude toward learning. Collaboration, covering Levels 2 and 3, involves the development of collaborative skills, problem-solving, and interpersonal communication, as well as the application of collaborative skills and teamwork-based problem-solving.

Course Outcomes: Empowered Students and Success

Ultimately, the goal of the online math course is to empower students to take ownership of their learning and leave the course satisfied with their successful course outcomes. Empowered students are those who have been actively engaged in their learning, have developed a deep understanding of gateway mathematical skills and concepts, and are prepared to apply their knowledge in future courses or real-world settings. These students have not only mastered the course material but have also developed valuable learning skills that will serve them well in their academic and professional endeavors. Leaving the 15-week course, empowered learners are eager to continue their academic journey in this new type of learning environment and are likely to enroll in other online courses in the future because they learned, enjoyed, and felt successful in their learning experience.

Student Success

Student success in this study encompasses several key indicators: passing rate, perceived level of learning and growth, engagement, and overall satisfaction with the course. Passing rate is determined by the proportion of students achieving a grade of C or higher, indicating mastery of course material based on course grading policy. Perceived learning and growth consider instances where students may have learned significantly despite grades not fully reflecting this growth, especially with assessments heavily weighted toward timed proctored exams.

Engagement reflects the extent of students' active participation in course activities and their sense of connection to the learning community. Overall satisfaction encompasses students' experiences, including their perceived effectiveness of instructional methods, quality of course materials, and support received from instructors and peers. These measures of student success are expected to enhance retention rates and future enrollment in online courses.

Significance of the Study

While prior research has examined student pass rates in different modalities of gateway math courses at NVCC, this study offers two distinctive features. First, it focuses specifically on the asynchronous online gateway math course NOL MTH 161 Precalculus I, a course with high enrollment at NVCC. This focus provided new insights into student success in online learning environments, offering perspectives that differed from traditional face-to-face, hybrid, or synchronous online courses. By concentrating on this specific modality, the study developed targeted recommendations and strategies to enhance student outcomes in asynchronous online learning. Additionally, the findings of this study could have broader implications, potentially informing educational practices not only within NVCC but also in other community colleges and institutions offering online gateway math courses. The insights gained from this research could help instructors and administrators better understand the unique challenges and opportunities of online learning, leading to the development of more effective and supportive online learning environments.

Second, instead of focusing only on pass rates and student demographics, this study will include additional measures of outcomes such as perceived levels of learning, growth, engagement, and satisfaction. By incorporating these aspects, the study aims to provide a more comprehensive understanding of student learning and success in online courses, which may impact retention and future online course enrollments. Qualitative insights from the exploratory case study method can reveal the impact of teacher and social presence on student success in online courses. Understanding the roles of instructors and peers in online learning environments can provide valuable insights into strategies that enhance student engagement and learning outcomes, thus contributing to a more holistic understanding of student success in online courses.

Overall, this study aims to collect data from multiple stakeholders in NOL MTH 161, generate findings, and provide recommendations for instructors and college leadership to expand online math course offerings and improve course quality to enhance outcomes. By collecting and analyzing qualitative data from students and instructors in NOL MTH 161, it placed instructors and students of NVCC Online as key stakeholders whose insights were heard and empowered to continuously enhance the college's online course offerings.

Key Terms and Definitions

Gateway Course: For the purpose of this study, a gateway course is defined as a foundational course characterized by large enrollment and a heightened risk of unfavorable outcomes, including grades of D, F, W (withdrawal), or I (incomplete) (Koch & Rodier, 2014). It is important to note that in this definition, foundational courses may include non-credit-bearing developmental or remedial courses, which often serve as a gateway to more advanced courses (Koch & Rodier, 2014).

Gateway Math Courses: Gateway math courses are the math courses students take in college. For this study, the gateway math course of MTH 161 Precalculus 1 was chosen, but it could include other courses in Quantitative Reasoning, Calculus, or even Developmental Mathematics depending on students' needs and program placement.

Asynchronous Online Course: These courses refer to fully online courses that offer “anytime, anywhere” learning flexibility. In asynchronous online courses, students are not required to attend any synchronous meetings for lectures or discussions but are expected to complete a set number of learning modules. Instructors act as facilitators rather than lecturers, and interactions often occur through online discussion forums.

Chapter 2 Literature Review

Asynchronous online gateway math courses present significant challenges for community college students in their first year. Many students who join community colleges with the goal of obtaining their associate's degree or transferring to four-year institutions often encounter difficulties in gateway math courses, which are known to have some of the highest failure rates among all community college course offerings (Chen, 2013; Koch & Gardner, 2018). These courses are often perceived as 'gatekeepers,' 'killer courses,' or 'weed-out courses,' presenting significant challenges for students navigating rigorous coursework alongside academic and financial pressures (Koch, 2017). For students in asynchronous online sections of these courses, the challenge is even greater. While some studies suggest that online instruction may not be as effective as face-to-face instruction, especially for students unprepared for college-level mathematics, many students, particularly those at community colleges, choose asynchronous online classes for benefits such as self-paced learning and flexible scheduling (Bird et al., 2020; Fuchs & Tsaganea, 2020; Xu & Jaggars, 2011).

Asynchronous online courses, unlike in-person or synchronous virtual classes, lack real-time direct instruction and student interactions. Therefore, students must possess a high degree of motivation and self-discipline to engage in independent learning, guided by an instructor who serves primarily as a facilitator rather than a traditional lecturer. This requirement is particularly challenging for first-year students, who are navigating their transition into higher education. These students may not only be adjusting to the asynchronous online learning environment but also grappling with the academic expectations of higher education for the first time.

Gateway math courses in community colleges, with their marked high failure rates among all gateway courses, represent significant obstacles to academic progress, hindering students' ability to obtain college degrees or transfer to four-year institutions in time (Attewell et al., 2006). Successfully completing these courses is particularly critical for students studying in STEM programs, as many underprepared college students enter these programs without the prerequisite mathematical skills and knowledge. A strong foundation in these gateway math courses is essential for students to progress to advanced-level courses in their STEM programs.

Chapter 1 highlights a persistent problem of practice at Northern Valley Community College (NVCC): despite the college's strategic goal to improve the completion rate of first-year gateway math courses, success rates for the STEM gateway course, MTH 161 Precalculus I, have stagnated at 20% to 41% over the past eight years (NVCC Office of Strategic Insights, 2022). This is particularly concerning for the asynchronous online sections of MTH 161 offered through the college's online platform, NVCC Online (NOL), which exhibit higher rates of unsuccessful outcomes (grades D, F, or Withdraw) compared to sections offered in other modalities. In response to NVCC's initiatives to better support online student learning through the expansion of its NOL offerings and to improve success rates in gateway math courses, this Capstone Project aims to explore the perceptions and experiences of both students and instructors in NOL MTH 161 course. Two research questions guiding this study are:

1. What factors do instructors perceive as supporting or hindering student learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?
2. What factors do students perceive as supporting or hindering their learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

This literature review examines empirical studies and seminal work on gateway courses, including gateway math courses, and asynchronous online learning in higher education. It is organized into three main sections. The first section reviews the background of gateway courses in higher education and their importance. The second section reviews gateway math courses and evidence-based practices that have been shown to improve student learning outcomes. The third section reviews the literature on asynchronous online learning in higher education. By analyzing the integration of gateway math course design and asynchronous online pedagogy, this review aims to better understand how these elements synergize to create an effective online learning environment that facilitates student learning. In response to the significant acceleration in online learning trends in community college education, this review focuses on critical empirical literature from 2014 onward to ensure relevance and timeliness.

Gateway Courses and First Year Experience

The search for 'gateway courses' in databases like ERIC and Google Scholar initially led to recent studies on student retention and first-year student experiences in higher education. Koch and Gardner emerged as two leading scholars in the field of First-Year Experience (FYE), with significant contributions over the past decades. To understand the role of gateway courses within the larger academic narrative of higher education, seminal work by Koch and Gardner was reviewed to see how gateway courses fit into the broader context of FYE and other higher education domains. This section aims to define and contextualize the issues surrounding gateway course completion and its importance in community college education.

Defining Gateway Courses

Gateway courses, often referred to as 'gatekeepers,' are the initial credit-bearing college-level courses in a program of study. Successfully completing these foundational prerequisites is a critical milestone for many college students working towards their academic goals, as these courses must be successfully completed with a grade of C or above before students can progress to advanced courses necessary for their degree completion. Examples of gateway courses include English Composition, College Algebra, Quantitative Reasoning, and others, depending on a student's intended major. These introductory courses typically enroll a significant number of first-year college students with varying levels of skills, knowledge, and academic preparation (Flanders, 2017; Koch, 2017)**.**

For the purposes of this literature review, I use the definition of gateway course crafted by the John N. Gardner Institute for Excellence in Undergraduate Education (Gardner Institute, 2014). A gateway course is any course that is foundational, marked by large enrollment and a heightened risk of unfavorable outcomes, including grades of D, F, W (withdrawal), or I (incomplete) (Koch & Rodier, 2014). It is noted that in this definition of a gateway course, foundational courses may include non-credit bearing developmental education or remedial courses, which often serve as gateways to the gateway courses (Koch & Rodier, 2014). Literature from both community college and four-year institutions is reviewed, with each study's setting clarified.

In both community colleges and four-year institutions, gateway courses are often referred to as “killer” courses because they can “kill” students’ GPA, motivation, and academic progress toward their goals (Koch & Pistilli, 2015). They pose a significant barrier to degree completion, as students face the greatest risk of poor performance or outright failure (Koch & Pistilli, 2015; Koch & Gardner, 2018). The consequences of failing these courses can be significant, particularly for students who rely on community colleges as a pathway to degree completion and career advancement (Koch, 2017; Koch & Gardner, 2018). Research shows that students who struggle in gateway courses often face financial barriers or are the first in their families to attend college (Koch, 2017). Failing gateway courses is closely linked to college dropout rates and has long-term consequences for student retention and degree completion. Gateway courses are often the student's first exposure to college-level learning and the program's standards, expectations, and content. As such, these courses play a crucial role in shaping a student's initial impression of higher education, their sense of belonging, and future success in college.

Between Fall 2021 and 2022, nearly 30% of all first-time, full-time first-year students dropped out of college (Hanson, 2023). Enrollment data in higher education indicates that one-third of DFWIs (grades of D, F, Withdraw, or Incomplete) come from just 1% of all courses offered, and 85% of course retakes occur in just 5% of all courses (EAB, 2020). Given that unsuccessful outcomes in gateway courses can create barriers to academic progress, addressing challenges in these courses is essential for improving student retention and success in higher education.

Gateway Course Completion and Academic Success

Researchers investigating college student achievement often explore various predictors such as high school GPA, standardized test scores, socioeconomic backgrounds, race, and gender to predict academic performance, course completion, retention, and graduation (Noble & Sawyer, 2004; Steele-Johnson & Leas, 2013; Walpole, 2003). Many of these factors are based on students' achievements before entering college or factors that cannot be controlled within a research context. To provide students with timely support before they drop out within their first year or semester of college, community college educators examine student achievement in gateway courses. Jenkins and Bailey (2017) highlight first-year metrics as key indicators of 'early momentum,' which predict student success and degree completion. Among these early momentum indicators, completing pathway-appropriate college-level math and English in the first academic year stands out as a critical component (Jenkins & Bailey, 2017).

In a quantitative correlational study using registrar data of 1,738 students, Flanders (2017) found that first-time, full-time freshman (FTFT) students enrolled at a large four-year institution who declared a major and successfully completed a gateway course within their program were more likely to persist than students who did not pass the gateway course in their program. Retention was defined as students returning in the spring semester of their first year. An important aspect of Flanders' study is the comparison between students who successfully passed a gateway course and those who passed a different college-level course that was not a gateway course within their program. Although both groups of participants passed a college-level course, the comparison indicates that it is specifically the gateway course that impacts retention. FTFT freshmen students who passed any college course but not a gateway course were 1.7 times less likely to enroll for their spring semester compared to those who passed gateway courses (Flanders, 2017).

The result supports the assumption that early momentum in gateway completion provides motivation for students to actively engage in their academic path because students' decision to go to college is affirmed, and they are more likely to reenroll to continue their learning in college (Flanders, 2017). This finding aligns with previous research on student retention, indicating that students who clarify their academic goals and complete courses within their intended major tend to achieve higher grades, demonstrate increased motivation, and integrate more fully into college life. These factors contribute to higher retention rates (Joyce, 2006; Moore and Shulock, 2009; Graunke & Woosley, 2005).

While Flanders' study (2017) was conducted at a large four-year Science, Technology, Engineering, and Math (STEM) institution and not in a community college setting, its participants were traditional-aged, first-time, full-time college students in their freshman year studying engineering and other STEM fields. This demographic similarity in age group and intended majors suggests that the findings may be applicable to the problem of practice for this inquiry problem of practice research context. However, it is important to note that the study does not specify the proportion of first-generation college students among its participants, a significant demographic in community college settings. While the primary focus of this inquiry will be on gateway math course design and instruction, it remains important to understand the demographic characteristics of the community college student population in gateway math courses. This information will allow for a comparison between gateway students in four-year universities and those in community colleges, highlighting any potential selection biases between these settings.

Koch and Gardner (2018) identified gateway courses as the 'missing piece' and 'missed opportunity' in the first-year experience movement due to the lack of attention to teaching and learning in these courses, particularly for students who may face additional academic and institutional barriers. More research on student retention in higher education has focused on freshman orientation and first-year student seminars as critical practices to improve FYE. Koch and Gardner suggest that the lack of attention given to gateway courses as a critical factor in earlier first-year experience initiatives can be attributed to the frequent turnover of administrators leading these efforts, while curricula are typically developed and overseen by teaching faculty (Koch & Gardner, 2018). While gateway courses have historically received less attention within the contemporary student success movement, which tends to prioritize expanded freshman orientation and seminars and other non-curricular or non-instructional focuses (Koch & Gardner, 2018), there is now a growing body of scholarship dedicated to gateway courses, offering evidence-based approaches and strategies that hold promise for improving student success rates (Koch, 2017).

Research consistently highlights the significance of early momentum, particularly within the domain of gateway math courses. Schudde and Keisler (2019), analyzing data from 20 community colleges in Texas, investigated the impact of an accelerated developmental math coursework model that enabled students to complete gateway math courses in their first year. Their findings revealed a strong positive relationship between achieving early college milestones, such as completing gateway math courses, and the accumulation of total college-level credits. Similarly, a study in Florida by Calcagno et al. (2007) discovered that community college students who successfully passed gateway math courses in their first year were more than twice as likely to graduate compared to those who did not pass during the same period.

Community College Students in Gateway Courses

Data from the Gateways to Completion (G2C) project, aimed at improving gateway courses, reveals that two-year community colleges experience higher average rates of D, F, W, and I grades (DFWI) in these courses compared to four-year institutions (Griffin & Koch, 2015). This disparity may be attributed to the open-access policies of community colleges, which admit all students regardless of their college readiness, while four-year institutions typically employ a more selective admissions process, filtering out some underprepared students (Koch & Gardner, 2018).

In both two-year and four-year institutions, STEM fields such as math report particularly high DFWI rates. These high failure and withdrawal rates can be attributed to the inherent difficulty of STEM courses, which often require a strong foundation in prerequisite knowledge and skills that many students may lack. Math courses, in particular, pose significant challenges due to their cumulative nature; gaps in understanding from previous educational experiences can greatly hinder students' ability to succeed in these courses. At community colleges, the open-access policy means that a significant number of students entering these courses are underprepared, exacerbating the issue. Even at four-year institutions, where admissions criteria are more stringent, many students still struggle with the rigorous demands of STEM coursework, leading to high DFWI rates (Griffin & Koch, 2015). This situation highlights the need for targeted interventions and support mechanisms to help students succeed in STEM gateway courses. Without adequate support, students are at risk of falling behind, which can impede their academic progress and diminish their chances of completing their degrees in STEM fields. Therefore, understanding and addressing the factors contributing to high DFWI rates in math and other STEM courses is critical for improving student outcomes and fostering success in higher education.

An extraordinary number of students enter community colleges each year underprepared to complete college-level coursework. National studies show that close to 60 percent of students in two-year colleges are taking remedial math, with the average student taking two to three successive courses at these institutions (Chen, 2016). While gateway courses typically exclude remedial or developmental courses because they do not count toward graduation or transfer credits, Koch and Rodier's definition of gateway courses, used for this literature review, includes these non-credit-bearing developmental education or remedial courses as they are foundational, marked by large enrollment, and a heightened risk of unfavorable outcomes. These courses often serve as a gateway to other gateway courses and are frequently taken by a significant proportion of underprepared community college students at the start of their academic journey (Koch & Rodier, 2014).

Some researchers argue that the presence of remedial gateway courses suggests that some students may not be adequately prepared for college-level work (Butrymowicz, 2017; Marcus, 2000; Williams, 2014). However, community colleges maintain open-door policies, admitting students with a range of academic backgrounds. As a result, educators must implement instructional strategies that support student success in both credit-bearing and developmental gateway courses (Roueche & Roueche, 1993).

The Pew Research Center (2020) found that undergraduate enrollment at U.S. postsecondary institutions has increased over the past 20 years, with growth particularly evident among students from economically disadvantaged backgrounds. Consequently, a disproportionate number of students from low-socioeconomic backgrounds attend the least-selective or open-access institutions (Fry & Cilluffo, 2020), including two-year community colleges. According to the American Association of Community Colleges, 42% of community college students in the United States are the first in their family to attend college.

While most research to date on STEM pipeline persistence from academia to the workforce has focused on four-year institutions, Cohen and Kelly (2019) studied the vital role community colleges can play in the education of STEM majors. In an explanatory observational study employing multiple regression analysis using transcript data from 1,511 community college STEM majors in the Northeast U.S., Cohen and Kelly (2019) found that students who first enroll in remedial math courses experienced a higher likelihood of changing to non-STEM majors, greater attrition, lower credit production, weaker science performance, and lower rates of graduation and transfer to four-year institutions. Their findings show that students who completed remedial math courses failed algebra and trigonometry at a rate of 68%, indicating that remediation coursework did not successfully prepare them for the math skills required for STEM. Such students are less likely than their peers to pass STEM courses, less likely to graduate with a STEM degree, and less likely to obtain a career in the STEM field. Their findings show that academic factors related to mathematics course-taking and performance in the first semester have a more significant impact on determining student STEM outcomes than any demographic variables (Cohen & Kelly, 2019).

Although causation cannot be determined as this study was correlational and not a random controlled experiment, the results indicate the important correlation between students' initial enrollment and performance in mathematics and STEM outcomes. The study did not look into instructor and math course variables including course design pedagogical strategies, and consistency of learning objectives and related assessments, so any variations from those variables could be explored for more insights.

Community College Students in Gateway Math Courses

Community college students enrolled in gateway math courses often include first-generation college students and those balancing part-time or full-time jobs alongside family responsibilities (CCRC, 2020). These factors, combined with the challenges of rigorous subjects like math, can significantly impact academic performance (Fry & Cilluffo, 2020; Griffin & Koch, 2015). Despite these challenges, students demonstrate perseverance and adaptability as they navigate their educational journeys. Supporting student success in gateway math courses requires acknowledging the multiple factors that influence learning. Factors such as math anxiety, prior educational experiences, and instructional approaches can influence students' confidence and performance.

In light of these challenges, community college students who are underprepared for college-level mathematics and place into remedial or developmental education gateway courses are at risk of failing, dropping out, or changing their major to a non-STEM field. Even if they bypass remedial math and start directly in credit-bearing college-level gateway math courses, their lack of prerequisite skills and knowledge can hinder their ability to learn and succeed in the course. The next section of this literature review examines the state of gateway math education in community college settings, focusing on evidence-based practices that show promising outcomes for students facing these particular challenges.

Gateway Math Courses in Community College

Gateway math courses have the highest failure rates among all community college course offerings, creating substantial barriers to attaining college degrees and/or transferring to four-year institutions (Attewell et al., 2006). Despite the persistent challenges of learning mathematics, these courses play a significant role in achieving higher education goals and enhancing career readiness (Hall & Ponton, 2005; McCormick & Lucas, 2011).

National studies indicate that nearly 70 percent of students beginning at public two-year colleges lack the necessary foundation for college-level math (Attewell et al., 2006). Math placement criteria have transitioned from being solely based on SAT Math scores or a single placement test result to now include multiple measures, such as high school GPA and prior math achievement, at many community colleges nationwide (Ngo & Kwon, 2014).

For instance, the Virginia Community College System (VCCS) no longer requires recent U.S. high school graduates and GED recipients to take the Virginia Placement Test (VPT). Instead, these students are placed into college-level math courses using a combination of placement measures, including high school GPA, GED scores, or SAT/ACT scores, as well as the highest level of math completed in high school. Students with a self-reported high school GPA of 3.0 or higher and completion of Algebra 2 are permitted to start in gateway math without the need for developmental education.

To provide more students with immediate access to college-level courses in their initial semesters, community colleges nationwide are increasingly adopting a direct placement approach (Adams et al., 2009; Bailey & Jaggars, 2016; California Acceleration Project, 2018). This approach involves allowing more students to enroll in gateway math courses regardless of their initial college readiness or mathematical preparation, paired with a support course or lab to scaffold the material, review prerequisites, enhance study skills, and build students' confidence and math identity (Park et al., 2018; Vandal, 2014).

The decision to place more students directly into credit-level math, bypassing developmental education requirements, does not eliminate the need to support underprepared or struggling students in gateway math classrooms. This reflects the challenge of working with students who enter with varying levels of preparation, reinforcing the importance of targeted interventions and effective teaching practices. Community colleges serve students with a range of commitments, including work and family responsibilities. To support their success in asynchronous learning environments, instructional strategies must be designed to enhance engagement and learning outcomes.

Evidence-Based Practice

The main question guiding this section of the literature review is ‘What evidence-based practices can enhance student success in community college gateway math courses?’ To provide clarity, 'evidence-based practices' refer to research-supported strategies acknowledged for their effectiveness in increasing student achievement (The IRIS Center, 2017). According to the Every

Student Succeeds Act (ESSA), these practices demonstrate a statistically significant effect on improving student outcomes. For this section, the focus is on practices with evidence levels categorized as strong and moderate. Strong evidence is based on at least one well-designed and well-implemented experimental study, and moderate evidence from at least one well-designed and well-implemented quasi-experimental study (ESSA, 2015).

This section focuses on two interconnected evidence-based practices—accelerated learning models and corequisite approaches—both of which demonstrate moderate to strong evidence in improving student outcomes in community college gateway math courses. The selected studies include large-scale empirical research published within the past decade, prioritizing rigorous methodologies such as randomized controlled trials (RCTs) and quasi-experimental designs to ensure reliability.

This section highlights studies that examine student outcomes in community college gateway math courses, with a focus on those offering strong or moderate evidence of effectiveness. Research focusing on non-college settings, specialized student populations, or studies older than ten years were excluded to maintain relevance. The following sections explore key findings from the literature on corequisite remediation and accelerated learning models, highlighting their impact on student achievement.

Mainstreaming and Corequisite Remediation Approach

Mainstreaming with corequisite support has demonstrated positive outcomes for gateway math student success. In a randomized controlled trial at three City University of New York (CUNY) community colleges, Logue et al. (2017) explored the impact of mainstreaming on student performance. The study involved 907 students, with 56% reporting English as their first language.

Participants were randomly assigned to either a gateway statistics course with corequisite workshops or traditional remedial algebra courses with weekly workshops covering algebra topics. The gateway math group exhibited a passing rate 16 percentage points higher than the remedial course group. One potential explanation for the higher pass rates in the intervention group, as discussed in the article, is the perceived lottery-like nature of the random assignment method, which may have motivated students. A critical limitation acknowledged is the qualitative difference between elementary algebra and introductory statistics, making direct grading comparisons challenging. However, the study effectively compared student success rates in typical remedial mathematics and gateway courses, revealing that students with access to gateway math with corequisite support achieved higher passing rates one year earlier than their counterparts who started in remedial math.

Typically, corequisite courses are taught by the same instructor as the paired credit-level course, enabling instructors to identify immediate student needs and provide just-in-time instructional support for optimal learning outcomes. Notably, in Logue et al.'s study, workshops were not led by the instructor teaching the paired gateway math but by student peers or graduates. To support implementation, instructors and workshop leaders attended orientation workshops, and training and met with researchers to discuss concerns and other issues as needed. This will be an important factor to consider when replicating the study or adopting a program like CUNY Start.

While the study cannot precisely determine the contributions of paired workshops to higher pass rates in gateway math because all participants placed into gateway math were required to attend corequisite workshops, it provides valuable insights for future research on the effectiveness of workshops and instructional practices. Subsequent studies can untangle the extent to which success results from enrollment in gateway math or specifically from corequisite workshops. This investigation prompted my exploration of qualitative literature on instructional strategies for corequisite courses or workshops influencing gateway math outcomes. Some recently published dissertations on corequisite models use qualitative design, but the existing literature lacks peer-reviewed qualitative research addressing the ‘why’ and ‘how’ of these outcomes.

A quasi-experimental study by Mireles et al. (2014) echoes the findings of Logue et al. (2017) but places a heightened focus on the curriculum and instructional aspects of the corequisite approach. This study assessed the efficacy of the FOCUS Intervention in a College Algebra gateway course at a four-year university in Texas. Regression analysis demonstrated that students in the corequisite course, as opposed to those in traditional remedial coursework, exhibited higher chances of passing the college-level course and lower withdrawal rates. The FOCUS Intervention integrates a corequisite model with weekly/monthly seminars, mentoring, and tutoring, establishing a comprehensive support structure. Notably, Mireles et al. (2014) highlight curriculum design and classroom learning structures, suggesting their applicability to other mathematics courses.

The study’s incorporation of ‘research-based best practices’ necessitates careful review. For instance, the Concrete-Representation-Abstract (CRA) model, while effective for younger students with learning disabilities in computational problems, lacks conclusive evidence for its applicability in postsecondary general education mathematics. Another highlighted practice in this study is discovery-based learning but existing research suggests the limited effectiveness of unassisted discovery learning. Research finds effectiveness of feedback, worked examples, scaffolding, and explicit explanations on student learning more than unassisted discovery learning (Alfieri et al., 2011). Although the intervention may have integrated explicit systematic instruction and inquiry-based learning for optimal results, the article lacks clear elaboration on the rationale or methodology behind the application of these promising practices to support student learning.

Moreover, with a focus on the curriculum and instructional aspect of the intervention, Mireles et al. (2014) fall short in specifically analyzing or discussing individual components within the identified ‘research-based’ practices deemed critical to the intervention. The analysis predominantly centers on quantitative outcomes, specifically comparing pass rates, neglecting a more in-depth exploration of curriculum design and instructional strategies. Furthermore, the study's limitations section raises concerns about the generalizability of results to community college students without providing further clarification. Another critical limitation involves different instructors teaching students in the intervention and comparison groups, introducing the significant factor of teacher impact and potential differences that must be acknowledged in studies of this nature.

In a study conducted by Kashyap and Mathew (2017), the performance of students in a freshman-level Quantitative Reasoning course, a crucial gateway for non-STEM programs, was examined under three distinct course sequence models, including the corequisite model. Surprisingly, the findings not only showcased superior performance among students in the corequisite model compared to the prerequisite group but also unveiled heightened enthusiasm for learning and increased classroom engagement. While the study’s focus was on 155 students at a small private liberal arts college, slightly diverging from the typical community college setting, its significance lies in the comprehensive gathering of both qualitative and quantitative data. This mixed-methods approach provided valuable insights into student performance and experiences under different instructional models.

Qualitatively, the study revealed that instructors in the corequisite model enjoyed greater flexibility in utilizing supplemental sessions, effectively addressing challenges faced by students in the gateway math course. Students expressed a sense of reduced pressure and increased comfort with the course material in the corequisite model, suggesting a positive impact on the learning environment. Moreover, the qualitative insights illuminated an intriguing aspect: students tended to forget the skills acquired through remedial work when they completed the prerequisite remedial course first, followed by the gateway math course in the subsequent semester.

Building on the insights gained from the mixed-methods study discussed above, another noteworthy exploration into the effectiveness of pedagogical strategies in the corequisite remedial model comes from Kim (2016). This investigation employs a mixed-methods approach to offer an understanding of just-in-time pedagogical support and its impact on student learning, mathematics self-efficacy, and achievement in the context of gateway math courses. The study defines just-in-time pedagogical support as encompassing one-to-one instruction, group work, and web-based learning in labs, aiming to enhance students' comprehension, reduce anxiety, and facilitate the learning of new materials in gateway math. This research was conducted at a large four-year university in the Southeast, and the lack of detailed sample demographics makes it difficult to determine how applicable the findings are to community college settings.

The researcher examined 252 participants in corequisite courses and found a significant improvement in students' mathematics self-efficacy and achievement. Employing questionnaires, semi-structured interviews, and document analysis, Kim (2016) improved the study's validity through triangulation and derived a model illustrating the relationships between pedagogical factors, emotional factors, and conceptual understanding. This model ultimately led to enhanced mathematics self-efficacy and achievement. These outcomes underline the critical role of mathematics self-efficacy, a factor vital in predicting students’ behavior, persistence, and achievement in education (Bandura, 1977).

Although interview data originated from a limited sample of 24 volunteers, the organized analysis of emerging themes and categories clarified the results and their implications for students’ academic progress. Notably, a key discussion point, echoing Mireles's findings, is that students’ strong motivation to attend lectures and labs stemmed from the opportunity to earn college credits and exit a remedial math program within the same semester. This aligns with the broader theme of strategies fostering early momentum and success in gateway math courses, setting the stage for the exploration of the next evidence-based practices, accelerated learning models.

Accelerated Learning Models

A second approach increasingly adopted by community colleges to improve gateway math success is an accelerated learning model that requires prerequisite workshops, boot camps, or a single-semester coursework to provide support before students enroll in gateway math.
A randomized controlled trial at four community colleges in New York evaluated the CUNY Start program's effects on 3,835 students (Weiss et al., 2021). Offered at a low cost of $75, this one-semester program utilizes a cohort model and provides up to 26.5 hours of instruction per week, emphasizing conceptual understanding, real-world learning, and academic skills. The article lists the components of the program, including administration, cost, and structure.

The most notable component related to the literature review question is the math instructional approach created by experienced faculty members and professional developmental staff members. CUNY Start's math curriculum emphasizes conceptual understanding, real-world learning, and building academic skills. Math pedagogy utilized includes the technique of questioning, where instructors ask specific open-ended questions to stimulate student thinking and discussion, giving students time to think about and struggle with the concepts, and encouraging them to speak and respond to each other (Weiss et al., 2021).

CUNY Start demonstrated significant success, increasing the percentage of students successfully completing a gateway math course by 5.2 percentage points within three years ($p = 0.004$). However, questions arise about the generalizability due to the intensive time commitment and skills tests required for exit. In assessing the generalizability of the study, the number of hours students had to dedicate, up to 26.5 hours per week, is far more than typical matriculated students in community colleges. Additionally, it is stated that CUNY required students to pass skills tests to exit developmental education, which could have been the motivating factor for students to participate in an intensive one-semester remedial course before they can enroll in gateway math.

It is unclear whether specific components of the CUNY Start model, such as interactive and participatory curricular and pedagogical reform in math, had a more significant impact on students' outcomes than the more common direct instruction approaches in many developmental education classrooms (Weiss et al., 2021). Future research can investigate whether instructional reforms can yield positive effects in less time-intensive interventions, extending beyond the compressed time frame that may have assisted students in focusing on their learning and acquiring skills more rapidly.

While no other randomized controlled study assessing gateway math pass rates received Tier 1 Evidence categorization from the What Works Clearinghouse (WWC), I reviewed an additional experimental study with a substantial sample size given that both randomized controlled trial (RCT) studies are from the same setting of New York Community Colleges. This Texas-based study falls under Tier 2 Evidence due to its quasi-experimental design, as researchers were constrained from utilizing RCT to capture causal effects.

Conducted by Schudde and Akiva in 2019, the study explored the ‘math pathways approach,’ condensed into the Dana Center Mathematics Pathways (DCMP) program. Unlike corequisite models, DCMP is a prerequisite course that compresses developmental course sequences into an accelerated, streamlined format covering the content of two or more courses in a single semester.

Analyzing 34,849 community college students across 24 institutions in Texas, researchers discovered that students in the DCMP program were approximately 13 percentage points more likely to pass college-level math in the subsequent term and 8 percentage points more likely to pass within two years (Schudde & Akiva, 2019). Controlling for demographic variables, the results show that DCMP participants consistently outperformed their peers in gateway math courses, suggesting the program's effectiveness in improving student outcomes. A limitation is the study's exclusive focus on non-algebra college-level math, designed for non-STEM majors. Consequently, findings might lack generalizability to other gateway math courses, particularly for algebra-intensive majors in STEM programs. Despite subsequent inclusion of algebra-intensive pathways in the DCMP, developed post-study, a gap remains in assessing the program’s efficacy in these courses.

Corequisite remediation stands out for its effectiveness in improving passing rates and reducing withdrawal rates. Logue et al. (2017) highlight the success of mainstreaming, affirming higher passing rates for students in gateway math with corequisite support compared to traditional remedial courses. The FOCUS Intervention, studied by Mireles et al. (2014), underscores the impact of curriculum design and instructional strategies on student success in corequisite courses. Accelerated learning models, exemplified by the CUNY Start program (Weiss et al., 2021), increase the percentage of students successfully completing a gateway math course. Schudde and Akiva (2019) introduce the ‘math pathways approach,’ revealing its potential to improve pass rates in college-level math. Each approach presents unique advantages and challenges. Corequisite, mainstreaming, and accelerated models each have strengths and challenges. Corequisites show strong success rates, while accelerated models offer streamlined options but require careful implementation to ensure effectiveness. Corequisite, mainstreaming, and accelerated models each have strengths and challenges. Corequisites show strong success rates, while accelerated models streamline remediation but require careful implementation to ensure effectiveness.

This Capstone project aims to explore the experiences and perceptions of students and instructors in a specific gateway math course offered in an asynchronous online format at the local community college. The goal is to understand the factors that facilitate learning in this unique context. The literature review will serve as an interpretive framework for this task, shedding light on the intersection of two key dimensions: gateway math education and asynchronous online learning. Therefore, the next section of my review will examine literature on asynchronous online instruction in higher education to analyze curricular and instructional practices tailored to meet the specific demands of learning in asynchronous online courses.

Asynchronous Online Learning

The enrollment of students in online courses continues to rise in public institutions, even as overall higher education enrollment declines (Allen & Seaman, 2017; Seaman et al., 2018). Online education offers significant advantages to students dealing with barriers such as limited geographical access, financial constraints, socioeconomic factors, and personal challenges (Hansen & Reich, 2015; James et al., 2016; McClendon et al., 2017). Despite its popularity, research indicates that outcomes for students in online courses are not consistently positive (Allen & Seaman, 2015; Xu & Jaggars, 2011; Lederman, 2018; National Center for Education Statistics [NCES], 2020). Students in online courses are more likely to withdraw, have lower retention rates, and perform less well compared to students in face-to-face courses, especially in fully online courses (Alpert et al., 2017; Bettinger et al., 2017; Figlio et al., 2013; Xu & Jaggars, 2013; Hart et al., 2016).

In a study examining 295,515 students in the Virginia Community College System, Bird et al. (2020) found the abrupt shift to online learning during the COVID-19 crisis resulted in a 6.7 percentage point decrease in course completion. Interestingly, faculty experience teaching online courses did not mitigate these negative effects, which appear to be driven by students' struggles with online learning (Bird et al., 2020). This finding may suggest that effective pedagogy in online courses requires more than just experienced online teachers; it also necessitates strategies to address the challenges faced by students who are new to online learning. As it is evident that the pedagogy supporting effective student learning in online courses differs from that in face-to-face courses, there is still much to understand about the nuances of student learning in this modality.

In reviewing literature related to student satisfaction and learning outcomes in asynchronous online courses, two main themes emerged: ‘Online Discussion’ and ‘Multimedia Instructional Materials’. Studies on online discussion have mixed findings on its effects on student learning. Some studies found that certain types of online discussion strategies are more effective in promoting students’ social and cognitive presence and can lead to student success, while others found online discussions only increased social presence, engagement, and or satisfaction, but no significant effect on student learning (Cho & Tobias, 2019; Lee & Recker, 2022; Jaggars & Xu, 2016). Multimedia instructional materials are explored in online learning literature as an approach to increase teaching presence. Studies show multimedia instructional materials like instructor-generated videos in addition to text-based instructional materials can increase student learning and satisfaction. In a study comparing different instructor-generated videos, Choe et al., (2019) found their participants rated videos with more instructor presence on screen, highly as they found them more engaging and satisfying compared to video styles with less instructor presence on screen as they found them as boring and not engaging. It should be noted that while student engagement and satisfaction are highly correlated to student learning and success, they are not synonymous. Students can enjoy and be engaged in an online class without necessarily achieving significant learning outcomes or passing the course. Conversely, students may be learning and passing, yet not find the course particularly satisfying. Both aspects, however, are crucial in the overall educational experience.

The studies reviewed support the Community of Inquiry (CoI) framework, which suggests that student success in online learning is influenced by three key elements: cognitive presence, social presence, and teaching presence (Garrison, Anderson, & Archer, 2000). Cognitive presence emphasizes meaningful learning through critical discourse and reflection, reflecting how students engage with course content and reflecting on concepts in an asynchronous online setting. Social presence highlights the importance of fostering interactions and a sense of community among students and instructors in an online environment. Teaching presence involves the design and facilitation of educational experiences, including instructional design and feedback, which is relevant to studying how instructional design and facilitation influence student learning outcomes in online courses. The CoI framework guides my understanding of insights from themes identified, helping me to comprehend why certain approaches are effective in enhancing student learning outcomes.

For this part of the review, inclusion criteria include scholarly articles published in peer-reviewed journals, focusing on undergraduate college student learning outcomes. Exclusion criteria involve studies that do not directly address student perception, experience, and learning outcomes in asynchronous online courses or that focus solely on graduate or non-U.S. undergraduate student populations.

Online Discussion – Social and Cognitive Presence

Social presence, defined as the ability to project oneself and establish personal and purposeful relationships (Garrison, 2007, p. 63), has been a focal point of research in online learning. This emphasis stems from the asynchronous nature of online courses, which often leads to students feeling isolated. Addressing this issue is critical to fostering a sense of community and belonging, thereby mitigating potential negative impacts on learning outcomes and overall course satisfaction (Swan & Shih, 2005). It is important to note that social presence goes beyond mere social interactions; it should also cultivate an environment characterized by open communication and group cohesion, aiming to build personal yet purposeful relationships (Garrison et al., 2007). Online discussion boards have emerged as popular tools within asynchronous online courses for engaging students in meaningful interactions. These platforms not only enhance social presence but also contribute to cognitive presence, directly influencing learning outcomes.

In a quantitative study, Lee and Recker (2022) analyzed 20,884 online discussion posts from 2,869 students across 72 introductory online mathematics and statistics courses at a medium-sized public university in the western U.S. The study examined the impacts of student and instructor participation in online discussions on students' course performance. Using text-mining techniques and manual coding to build and select machine learning models, the researchers analyzed a large corpus of textual data collected by the Canvas Learning Management System (LMS). Students' final grades were used to measure their performance. The findings revealed that while average message length was not statistically significant, the total number of messages read, posted, and replied to, which researchers refer to as online speaking and listening, were statistically significant predictors of students' final grades.

In addition to examining the quantity of students' discussion posts, the researchers reviewed the quality and content of their posts. They found that posts contributing in argumentative/evaluative ways, applying new knowledge, synthesizing peers' multiple solutions, or evaluating others' approaches to solve problems were statistically significant predictors of students' final grades. One interesting finding was that posts related to teamwork planning had a statistically significant negative regression coefficient, indicating a potential negative impact on final grades. This sounds similar to students engaging in extraneous cognitive load in face-to-face classroom, making students cognitively overloaded to process intrinsic cognitive load for learning.

However, this study cannot definitively determine whether deep and collaborative discussions led to higher final grades or if distracted student discourse away from the main discussion focus led to lower performance. It is plausible that students who learned more engaged in higher quality discussions, while those needing more guidance sought peer support in collaborative settings. An additional limitation of this study is the lack of available data on certain course implementation details and characteristics of students and instructors due to data privacy policies when the data was automatically harvested by the LMS. Furthermore, the study did not analyze the relationship between two or more posts or conversations, which could provide more insights into social presence and its relationship to effective and open communication.

While online speaking and listening in online discussion posts and peer interactions correspond to the social presence aspect of the CoI framework, Lee and Recker's finding regarding the substantial effect of instructors using open-ended prompts on students' final grades reflects the cognitive presence and its impact on student learning. This finding is consistent with prior research indicating that open-ended prompts not only increase the quantity but also enhance the quality of interactions in online discussions (Bradley et al., 2008; Ke & Xie, 2009). Engaging in open-ended, sense-making mathematical conversations, rather than simple problem-solving, can enrich online discussions and promote cognitive presence. The growing use of Artificial Intelligence (AI), such as ChatGPT, in online courses raises questions about its influence on discussion dynamics. Future research could explore how students engage in online discussion activities, particularly in light of the increasing integration of AI in recent years.

While meta-analyses are not the main sources for this review, findings from them suggest a similar conclusion to what Lee and Recker (2022) found regarding students' active discussion of teamwork not having significant impact on final grades. In a meta-analysis that examined 19 quantitative studies with correlational and regression research designs, Martin et al. (2022) found a moderate correlation between social presence and perceived learning ($r = 0.432$), a moderate correlation between social presence and satisfaction ($r = 0.447$), and a weak correlation between social presence and actual learning ($r = 0.199$). This is consistent with findings from earlier studies that social presence has little to no relationship with learning outcomes but is associated with course satisfaction (Akyol & Garrison, 2008; Joo et al., 2011; Richardson & Swan, 2003; Richardson et al., 2017; Shin, 2003; Swan & Shih, 2005). Studies examining the effects of social presence in online courses often distinguish between students' 'perceived learning' or 'satisfaction' and 'actual learning' as two different constructs (Carperter et al., 2013; Richardson & Swan, 2003). This suggests that actual and perceived learning are separate constructs to be explored in this inquiry.

Despite promoting online speaking and listening to enhance social presence, not all online discussions can effectively promote various levels of cognitive presence crucial for students to construct knowledge. Cognitive presence, defined as learners' ability to construct and confirm meanings through reflection and discourse, consists of four phases: triggering event, exploration, integration, and resolution (Garrison et al., 2001). Understanding which discussion prompts can stimulate student learning requires careful examination.

Darabi et al. (2010) conducted a mixed-methods study to investigate cognitive presence in asynchronous online learning, comparing four discussion strategies: structured, scaffolded, debate, and role play. Qualitative data from 73 students enrolled in a 15-week online section of an undergraduate course delivered via the Blackboard LMS was transformed into quantitative data through coding and ratings by multiple raters, analyzed using descriptive statistics, and subjected to a goodness-of-fit test for comparison (Darabi et al., 2010). Participants in this study were all juniors and seniors at a large university in North America, divided into four groups and randomly assigned to four discussion groups.

Their findings indicated that different strategies were more effective at activating specific phases of cognitive presence. For example, while the structured strategy was strongly associated with the triggering phase of cognitive presence, it did not lead to discussions on the resolution phase. The scaffolded strategy, which included an element of a graduate student mentor leading the discussion, exhibited a strong association with later phases of cognitive presence, such as the resolution phase. The debate and role-play strategies generated a high number of posting segments across cognitive presence and were highly associated with the exploration and integration phases. These results suggest that discussion strategies involving learners in authentic scenarios can enhance cognitive presence, critical thinking, and overall learning outcomes.

One limitation of this study is that all participants were experienced college students in their junior and senior years, who may differ from novice learners in gateway courses at a community college. Notably, the study did not consider demographic variables, such as students' age, experience with online learning or prior knowledge about the subject area, which could have had a significant impact as confounding variables. Further research could explore the effects of blocking participants by their experience with an online course or their prerequisite knowledge and skills in a gateway math course to determine if similar results are observed. Investigating which type of discussion strategy is effective for different types of lessons and students could be an interesting avenue for future research, as certain subject areas may be more suitable for specific discussion types.

Multimedia Instructional Materials – Teaching Presence

Carefully designing and selecting various discussion prompts can be categorized under ‘selecting contents’, an overlapping area of cognitive presence and teaching presence in the CoI framework. In the previous subsection, I reviewed literature related to instructional design and organization, focusing on teaching presence. Teaching presence is defined as “the design, facilitation, and direction of cognitive and social processes for the purpose of realizing personally meaningful and educationally worthwhile learning outcomes” (Garrison, 2007, p. 5). This section explores the impact of multimedia instructional materials and instructor-generated videos on student learning outcomes.

Choe et al. (2019) conducted a mixed-method study to identify online lecture video styles that could enhance student engagement and satisfaction while maintaining high learning outcomes in asynchronous online courses. They created eight video types aligned with Mayer’s multimedia learning principles, which are akin to Sweller’s Cognitive Load Theory but adapted for online instructional videos. Mayer’s principles emphasize understanding and working within the learner’s cognitive capacity to prevent overload and maximize learning. Key components include segmenting, pretraining, modality, coherence, redundancy, signaling, spatial continuity, and temporal continuity principles to reduce distractions. Mayer also includes the voice principle and personalization principle for enhancing student engagement (Mayer & Fiorella, 2014; Sweller, 2014). These evidence-based multimedia principles in asynchronous online courses can help institutions expand access to high-quality instruction while using resources efficiently (Clark, 2014).

Since all eight video styles adhered to Mayer’s principles, they were all effective, but participants favored certain types for different reasons. The videos included Classic Classroom, Weatherman, Demo, Learning Glass, Pen Tablet, Interview, Talking Head, and Slides On/Off, all recorded by a professional recording studio with the same instructor. Findings revealed that students preferred the Learning Glass style and Demo style, giving them the highest satisfaction ratings due to their personal, engaging nature and positive affective responses. While some types were perceived as boring and unengaging, the results indicated that any of the six other didactic styles, such as the Pen Tablet and Slides On/Off, could produce equal learning outcomes at a lower cost, which could be valuable for institutions with budget constraints for video production.

However, a significant limitation of this study was that the 183 voluntary participants were University of California, Los Angeles (UCLA) students in upper-division core physiology courses in their third or fourth year of college. Therefore, the findings may not be representative of all students, and generalizing these results to gateway math students in community colleges may not be appropriate. For instance, the researchers noted that their participants were 'advanced students' who could learn equally across different video styles, suggesting that these students might already possess the necessary skills to learn in various online settings. Future research should aim to identify the specific skills, experiences, or institutional factors that enable students to succeed across a variety of instructional styles (Choe et al., 2019).

Another quantitative study reviewed instructor-generated video lectures in an online College Algebra course, a gateway math course, at an open-enrollment university in the Midwestern United States. Hegeman (2015) compared student performance in the original online College Algebra course, which relied heavily on text-based multimedia tools from the publisher, to student performance in a redesigned online College Algebra course. The redesigned course enhanced the instructor's teaching presence by requiring students to complete guided note-taking sheets while watching instructor-generated video lectures and removing publisher-generated learning aids (Hegeman, 2015). This study provided valuable background information on the current state of most asynchronous online math course designs, which use text-based, interactive multimedia tools like ALEKS and MyMathLab, emphasizing content mastery and providing immediate feedback to students during the solution process.

Participants in the study self-enrolled in the redesigned course and were not randomly assigned. While the researcher found no statistically significant differences between the two groups in terms of mean age and mean ACT math scores, students in the redesigned group were slightly older and had higher mean ACT math scores. Another limitation was that students who remained on the course roster but did not actually complete the course due to nonattendance without officially withdrawing were deleted from the analysis. A significant concern for bias was that the researcher was the course instructor who generated all the materials. IRB approval was not required for this study, as the author was simply teaching the online course differently from how it had been taught previously, but her unintentional bias may have influenced the outcomes (Hegeman, 2015).

Despite these limitations, the study's findings offer valuable insights into strategies that may benefit students in asynchronous online math courses. The results indicated that increased teaching presence significantly predicted student success across various aspects of the course, including homework, quizzes, exams, and final grades. Additionally, the redesigned course showed a lower attrition rate (Hegeman, 2015). The research suggests that removing publisher-generated learning aids from the online homework system, such as the "View an Example" and "Help Me Solve This" features preferred by students and replacing them with instructor-generated lecture videos providing comprehensive instruction for mathematical concepts, can help shift the focus from procedural learning to conceptual understanding in mathematics education (Hegeman, 2015). Moreover, the redesign of the course emphasized the prominent role of the course instructor as the content provider, thereby enhancing teaching presence in the online environment. It is worth considering the note-taking aspect as a potential contributing factor to these outcomes. Further qualitative insights could complement and enhance these findings, providing a deeper understanding of the mechanisms underlying student success in asynchronous online gateway math courses.

The final article reviewed for additional qualitative insight involved a study in which a researcher interviewed eight award-winning online faculty members from across the U.S., all of whom had received online teaching awards from one of three professional associations, the Association for Educational Communications and Technology (AECT), the Online Learning Consortium (OLC), and the United Stated Distance Learning Association (USDLA). Kumar et al. (2019) developed a semi-structured interview protocol consisting of fourteen open-ended questions and conducted thirty-minute web-based interviews with all eight participants out of 15 originally invited. Interviews were digitally recorded and analyzed using codes. The section on data analysis in the article could have been more informative, as it was somewhat brief.

The findings of this study highlighted several components of award-winning course design, including course announcements and reminders, course information documents, and feedback. Award-winning instructors also stressed the importance of authentic online course materials, digital resources, and multimedia resources to enhance student motivation to learn. Additionally, the study emphasized the significance of students' reflection on learning and their creation of content both individually and collaboratively. Lastly, participants emphasized the importance of using data and evaluation practices, as well as being willing to learn for continuous improvement (Hegeman, 2015).

One limitation of this study is that the responses were based on participants' memories and personal accounts, which may not have fully addressed all aspects of their course design. This limitation could have been addressed through triangulation, which was not used in this research. Triangulation methods such as observing award-winning courses, reviewing course syllabi, engaging in peer debriefing, or prolonged engagement could have enhanced the rigor, credibility, and trustworthiness of the findings, as discussed in the limitations section of the article. It would be valuable to examine students' interview data for qualitative insights. However, such data was not found in my literature search. Understanding students' perspectives could provide valuable insights into what helps them learn effectively in online mathematics courses. It's going to be necessary to distinguish perceived learning versus actual learning based on the literature review. This gap in the literature highlights a direction for future research, which could focus on gathering and analyzing students' perspectives to inform the design of online courses and enhance student learning outcomes.

Conclusion

This literature review aims to deepen understanding of the challenges and significance of gateway courses, evidence-based gateway math instruction, and asynchronous online learning, particularly in relation to student engagement, satisfaction, and success in asynchronous online gateway math courses. It contextualizes the importance of passing gateway courses in a student's first year, as it significantly increases college retention, academic momentum, and success, particularly for underprepared and unrepresented students in community college settings. Additionally, the review stresses the need for more research, especially in the context of community college gateway math, to inform evidence-based approaches, drawing insights from promising practices in other educational contexts.

Discontinuing online learning opportunities due to their lower success rates compared to face-to-face or virtual synchronous courses is not a viable solution. Online training and learning are integral aspects of modern education. Higher education institutions must support their students to become successful online learners, fostering their personal and professional growth beyond academic endeavors, promoting lifelong learning.

Quantitative studies have identified key elements of asynchronous online courses that are significant predictors of student success. However, there is a research gap concerning students in the lowest levels of math courses, particularly at open-access community colleges serving vulnerable student populations. An exploratory case study at Northern Valley Community College (NVCC) can shed light on the dynamics influencing success in community college gateway math courses delivered asynchronously online. This literature review has informed the creation of priori codes to analyze qualitative data collected from students and instructors in NVCC's NOL MTH 161 sections. By analyzing this data, I aim to gain a deeper understanding of the perceptions, experiences, and factors influencing student engagement, satisfaction, and learning outcomes.

Insights from the case study with students and instructors in NOL MTH 161 at NVCC can significantly contribute to the growing literature on online learning experiences in gateway math courses. By pursuing these research directions, my Capstone Project can actively contribute to the ongoing conversation in developmental and gateway math education reform within community colleges, specifically targeting the challenges faced by students and instructors in asynchronous online sections. This effort aims to improve student access and success in gateway courses at community colleges, ensuring more learners achieve their educational goals.

Chapter 3 Methods

This study was designed to explore the perceptions and experiences of students and instructors in the asynchronous online gateway math course, NVCC Online (NOL) MTH 161 Precalculus I, to better understand various factors that either supported or hindered student learning in asynchronous online gateway math courses. The research is centered around the following questions:

1. Research Question 1: What factors do instructors perceive as supporting or hindering student learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?
2. Research Question 2: What factors do students perceive as supporting or hindering their learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

Chapter 1 provided a brief overview of the problem of practice, its rationale, and the evidence supporting its existence. Chapter 2 reviewed existing literature, emphasizing the importance of gateway course completion and research on gateway math and asynchronous online learning that could impact student satisfaction and learning outcomes. This exploration was guided by the conceptual framework (illustrated in Figure 1.1), which highlights the interplay between teaching presence, cognitive presence, social presence, student satisfaction, learning, and student success.

This chapter outlines the research methodology that was employed to investigate these questions. It includes a description of the study design, the context of the study, the participants, the sampling methods, and summaries of the data collection and analysis processes.

Additionally, the chapter addresses the study’s ethical considerations, its trustworthiness, limitations, and delimitations.

Research Design

This study employed a qualitative exploratory case study design to gain an in-depth understanding of the problem of practice, primarily from the participants' perspectives. While NVCC had already collected quantitative data on course completion rates in gateway math courses, a qualitative approach was deemed necessary to obtain a deeper understanding of the issue and to identify factors that support or hinder student learning in the asynchronous gateway math course, NOL MTH 161 Precalculus I, to improve student success. This approach involved exploring the perceptions and experiences of students and instructors of NOL MTH 161, which was particularly relevant for obtaining rich, context-specific insights (Hancock et al., 2021). The case study was an empirical investigation of the problem of practice within its natural context, utilizing multiple sources of evidence, such as instructor interview transcripts, student survey results, and existing documents publicly available like the course syllabus (Hancock et al., 2021; Yin, 2018).

This study was exploratory in nature, seeking to define research questions for potential subsequent studies to better understand student learning in NOL gateway math courses. Given the limited existing knowledge about this specific context, an exploratory study to generate relevant hypotheses and propositions about student learning and success in these courses was necessary (Hancock et al., 2021). While case studies are sometimes criticized for lack of generalizability (Merriam, 2001), insights gleaned from a case study can directly influence procedures and future research (Yin, 2018). By identifying factors that students and instructors perceived as supporting or hindering student learning in NOL MTH 161, future studies may build upon this research.

This single case study was also an instrumental study, focusing on two participant groups to provide insights into a specific issue of asynchronous gateway online math courses in a community college setting. In this type of investigation, details of the perceptions and experiences of the instructors and students in NOL MTH 161 contributed to the understanding of the uniqueness and complexity of the case (Stake, 1995). However, the primary focus was on how these perceptions and experiences illustrated the potential effectiveness of instructional design and pedagogical support in asynchronous online gateway math courses, particularly in the community college setting (Stake, 1995). While the focus was on a specific case at NVCC, the intention was for the findings to contribute to the broader body of knowledge in the field of instructional design and pedagogical support in community college online gateway math courses. The particular case studied to gain insight into this issue is described next.

Context

Northern Valley Community College (NVCC) is a large multi-campus community college in a Southern state, serving more than 75,000 students. NVCC comprises six campuses and four centers, enrolling students with a wide range of academic backgrounds, experiences, and goals. As an open-access institution, NVCC serves learners at various stages of their education and career paths, including recent high school graduates, adult learners, and those seeking career advancement. The college is experiencing a significant increase in online course enrollments, with community college students seeking flexible options to pursue education asynchronously online, without attending synchronous, in-person, or virtual classes. NVCC's mission is to “come as you are and become who you want to be,” reflecting its commitment to student achievement and academic growth.

This case study examined students’ and instructors’ perceptions and experiences of an asynchronous online gateway math course offered through NVCC Online, formerly Extended Learning Institute (ELI). NVCC Online provides students with flexible class formats, allowing them to fit education into their busy lifestyles from anywhere in the world. NVCC Online, with a long history of distance education dating back to 1975, offers over 300 courses in more than 50 academic disciplines, along with 19 associate degrees and 16 certificate programs that can be earned entirely online (NVCC Institutional Research Report, 2023).

In the 2021-2022 academic year, NVCC saw a significant increase in online course enrollment, with 26,576 students taking distance learning classes and 6,227 enrolled full-time online. From Fall 2018 to Fall 2022, most NVCC Online students were part-time (72%), and about 65% were 21 years or younger. Nearly 40% of incoming students did not have a high school GPA of 3.0 or higher and had not completed Algebra II, which may impact their readiness for college-level math (NVCC Fact Book, 2018-2019 through 2022-2023).

This case study provided a detailed understanding of student and instructor experiences in the NOL MTH 161 course to identify factors that support or hinder student learning. By exploring these perceptions and experiences, the study informed strategies that can improve student success in online gateway math courses at NVCC. The course under examination, MTH 161 Precalculus I, is a 15-week course comprising four modules. These modules cover a range of topics, including Functions and Relations, Polynomials, Exponential and Logarithmic Functions, and Systems of Equations.

Course Content & Elements

The NOL MTH 161 Precalculus I course included a variety of structured activities and assessments designed to support student learning. Throughout the course, students engaged in various activities such as completing two homework assignments weekly using ALEKS, an artificially intelligent learning and assessment system, four module quizzes, and four proctored assessments. Additionally, students participated in five discussion board activities. The discussion board activities included an initial introduction and four activities designed to facilitate discussion and preparation for each module exam. Exams were proctored using the Respondus Lockdown Browser.

Grading was structured with the syllabus quiz and discussions accounting for 5% of the total grade, proctored assessments (module exams) counting for 70%, ALEKS homework contributing 10%, and ALEKS quizzes weighing in at 15%. To pass the course, students had to achieve at least a 60% average on the proctored exams. The following subsection describes the participants in this study and the sampling strategy employed for data collection.

Participants and Sampling

In case study research, the researcher identifies key “participants in the situation whose knowledge and opinion may provide important insights regarding the research questions” (Hancock et al., 2021, p. 52). This study gathered data from two participant groups: instructors teaching NOL MTH 161 sections and students enrolled in these sections during the Fall 2024 semester.

Instructor Participants

Data collection began with instructors, following a process for selecting participants to address the following research question:

Research Question 1: What factors do instructors perceive as supporting or hindering student learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

Step 1: Initial Pool of Fall 2024 NOL MTH 161 Instructors.

From an initial pool of 16 instructors who taught a section of MTH 161 across various formats—including the regular 15-week session, the first 7-week accelerated course, and the second 7-week accelerated course—the study focused on those teaching the 15-week regular academic session of NOL MTH 161. This subset included seven instructors. These instructors provided a representative sample of teaching practices and experiences within the 15-week course format, ensuring that the study captured the nuances specific to this standard course length.

Step 2: Exclusion Criteria.

Instructors teaching shorter terms (7-week sessions) were excluded, as the challenges associated with teaching and facilitating learning in accelerated courses could confound findings. For instructors who taught both 15-week and 7-week classes, they were asked to reflect specifically on their experiences with the 15-week course format.

Step 3: Campus Representation.

At least one instructor from each campus was included in the inclusion criteria, and all seven instructors were invited to participate in the study via email (see Appendix A – Instructor Survey Invitation Email). The study aimed to ensure representation from NVCC's five campuses: Riverdale, Oakwood, Fairview, Hillcrest, and Pinewood[2]. The final sample included six instructors who responded to the survey, resulting in a response rate of 86%.

[2] Campus names (Riverdale, Oakwood, Fairview, Hillcrest, and Pinewood) are pseudonyms used to protect the anonymity of participants and locations.

Step 4: Selection of Sample.

The final sample included six instructors, with representation from three definitively identified campuses: Riverdale, Oakwood, and Fairview. Two instructors were from Riverdale, two from Oakwood, one from Fairview, and one did not identify their campus affiliation. This approach captures perspectives and experiences from multiple NVCC campuses, though it does not include representation from all five campuses as initially intended.

Instructor Information.

Table 3.1 presents a detailed overview of all instructors assigned to the 17 sections of NOL MTH 161 in Fall 2024, including class lengths and campus affiliations. Pseudonyms have been assigned to all instructors to protect their confidentiality. While the table lists all 17 sections, only the first seven rows represent instructors who taught the 15-week sessions, which were included in the study's inclusion criteria. These seven instructors were invited to participate in the study, as the focus was on the regular 15-week course format.

Table 3.1

All NOL MTH 161 Instructors in Fall 2024

Numbers	Section	Name	Class Length	Campus
1	E01R	Daniel Carter	15-weeks (8/26 – 12/17)	Riverdale
2	E02O	Rachel Monroe	15-weeks (8/26 – 12/17)	Oakwood
3	E03F	Maria Garcia	15-weeks (8/26 – 12/17)	Fairview
4	E04H	Linh Nguyen	15-weeks (8/26 – 12/17)	Hillcrest
5	E05R	Susan Foster	15-weeks (8/26 – 12/17)	Riverdale
6	E06P	Raj Kapoor	15-weeks (8/26 – 12/17)	Pinewood
7	E07F	Linda Harris	15-weeks (8/26 – 12/17)	Fairview
8	E08F	Megan Wright	First 7-weeks (8/26 – 10/13)	Fairview
9	E09O	Priya Sharma	First 7-weeks (8/26 – 10/13)	Oakwood
10	E10H	Jennifer Brooks	Second 7-weeks (9/9 – 10/27)	Hillcrest
11	E11O	Priya Sharma	Fourth 7-weeks (10/23 – 12/17)	Oakwood
12	E12R	Heather Collins	Fourth 7-weeks (10/23 – 12/17)	Riverdale
13	E13P	Julie Marino	Fourth 7-weeks (10/23 – 12/17)	Pinewood
14	E14P	Arjun Patel	Fourth 7-weeks (10/23 – 12/17)	Pinewood
15	E15H	Nancy Blake	Fourth 7-weeks (10/23 – 12/17)	Hillcrest
16	E16R	Karen Wallace	Fourth 7-weeks (10/23 – 12/17)	Riverdale
17	E17P	Margaret Dawson	Fourth 7-weeks (10/23 – 12/17)	Pinewood

Student Participants

Following data collection from instructors, the study focused on student participants to address the second research question:

Research Question 2: What factors do students perceive as supporting or hindering their learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

Step 1: Initial Pool of Fall 2024 NOL MTH 161 Students.

The student group consisted of students enrolled in the 15-week NOL MTH 161 sections taught by the seven selected instructors. While each section could have up to 36 students (a theoretical maximum of 252 students), the sampling frame provided by the NVCC Research Office identified a total of 248 students enrolled in these sections.

Step 2: Exclusion Criteria.

Only students enrolled in the 15-week sessions were included in the study. Students from shorter terms (7-week sessions) were excluded to ensure consistency in evaluating experiences specific to the 15-week course format.

Step 3: Recruitment and Sampling.

Students were invited to participate in the survey via email (see Appendix B – Student Survey Invitation Email). The Director of NVCC Online facilitated the initial recruitment by sending out seven separate emails to students enrolled in each of the 15-week sections of MTH 161. Subsequently, the NVCC Research Office provided the sampling frame, which included the names and email addresses of the 248 students enrolled in these sections. Due to system constraints in Qualtrics that prevented sending all 248 invitations at once, email invitations were sent via email in smaller batches over a two-week period.

Surveys were distributed starting the week following IRB approval, which was granted on November 5. This delayed the original plan to send surveys in September. While the delay shortened the data collection period relative to the initial timeline, it ensured full compliance with ethical requirements. The survey remained open for three weeks, allowing sufficient time for students to respond.

The email outlined the purpose of the study, the voluntary nature of participation, and the potential benefits of contributing their perspectives. The timing of the survey allowed data to be collected late in the semester, capturing insights from students who were still actively enrolled in the course, as well as those who might have been considering withdrawal. This approach provided a comprehensive view of the factors influencing both retention and withdrawal decisions. Efforts were made to retain student participation throughout the survey period, including sending reminder emails and emphasizing the value of their contributions. All participants were de-identified and assigned pseudonyms to ensure their confidentiality.

Data Collection

To ensure a richly descriptive case study grounded in deep and varied sources of information (Hancock et al., 2021), this study employed multiple phases of data collection. The data collection process was carried out in three distinct phases: Surveys, Focus Groups, and Document Analysis.

Phase 1: Surveys

The first phase of data collection involved administering surveys to both instructors and students of NOL MTH 161. Following IRB approval on November 5, 2024, surveys were distributed starting the week of November 8. The NVCC Online Director initially sent emails to students in the seven 15-week sections, and the researcher followed up by sending email invitations using Qualtrics over two weeks due to system constraints. The surveys remained open until November 29, 2024. The adjusted timeline ensured the inclusion of students still enrolled after the census date while capturing perspectives of those actively participating in the course, offering a comprehensive view of factors influencing both retention and withdrawal decisions.

Survey Structure.

The survey, structured around the Community of Inquiry (CoI) framework and incorporating elements of the Kirkpatrick Model to measure effectiveness, consisted of the following parts for both instructors and students. Although the wording differed to suit each group's context, the core structure remained consistent:

Teaching Presence and Instructional Effectiveness.

Informed by the CoI framework and supplemented by the Kirkpatrick Evaluation Model, this section evaluated teaching presence, encompassing instructional design, teaching methods, and the perceived effectiveness of the curriculum. It explored participants' perceptions of course organization, clarity of instructions, and the relevance of course content to learning goals. Level 1 (Reaction) was assessed by examining participants' immediate responses to teaching methods and materials, while Level 2 (Learning) focused on measuring perceived knowledge and skill acquisition. The student survey included a question on the quality of instructor feedback in improving mathematical understanding, alongside a common question asked in both the instructor and student surveys about the frequency and timeliness of feedback.

Cognitive Presence and Learning Outcomes.

This section assessed cognitive presence, measuring perceived learning outcomes, knowledge acquisition, and skill development. Questions evaluated how the course facilitated critical thinking and problem-solving, aiming to understand the depth of learning and the ability to apply knowledge. This part assessed Level 2 (Learning) and Level 2.5 (Behavior) by exploring how effectively participants believed they had mastered the material and their initial efforts to apply the new skills in real-world contexts.

Social Presence and Engagement.

Focusing on social presence and engagement, this part assessed the level of interaction with peers and instructors, participation in discussions, and the sense of community within the course. Questions covered aspects such as attendance, participation in activities, and the overall learning environment. This section captured data for Level 1 (Reaction) by assessing participants' engagement and satisfaction with these interactions.

Satisfaction and Commitment to Application.

Integrated into the previous sections, this component measured satisfaction with the course and its impact on attitudes, confidence, and commitment to applying learned knowledge. It explored overall satisfaction, perceived value of the course, and intention to use the acquired knowledge and skills, thus addressing Level 2.5 (Behavior) and Level 3 (Results).

General Comments and Reflections.

This section provided an open-ended opportunity to share additional thoughts on learning experiences, challenges faced, and suggestions for course improvement.

Demographic Information.

The demographic section of the survey gathered information on participants' full-time enrollment status, and perceived readiness for both math and asynchronous online courses. Participants were asked about their full-time student status, and how ready they felt to take MTH 161 Precalculus I and to participate in an asynchronous online course. The responses provided insight into the participants' background and preparedness for the course.

Instructor Survey.

The Instructor Survey was designed to capture instructors' perspectives on teaching presence, cognitive presence, social presence, and the effectiveness of instructional methods. The survey included both rating-scale items and open-ended prompts. Instructors were also given the opportunity to express interest in participating in a one-on-one interview for a $25 gift card. The responses from this survey helped shape the one-on-one interview questions and identified key themes for further document analysis.

Student Survey.

The student survey was distributed to all 248 students in the sampling frame across the seven 15-week sections taught by the selected instructors. It assessed student engagement, perceived course effectiveness, learning outcomes, and overall satisfaction. Additionally, the survey included a question asking students if they were interested in participating in a 30-minute focus group for a $25 gift card. Students who expressed interest and provided detailed feedback, along with those demonstrating high engagement levels, were invited to participate, ensuring that focus group discussions captured a range of perspectives.

Survey Data Utilization.

Based on the analysis of survey data, the interview and focus group protocols were refined to address key themes that emerged. For instance, instructors' survey responses highlighted challenges with quizzes and exams not accurately assessing student learning, prompting the inclusion of specific questions about the design and alignment of these assessments with instructional goals and their impact on student outcomes. This adjustment allowed for a deeper exploration of how assessment practices support or hinder learning.

Survey feedback also emphasized the importance of synchronous support during office hours, leading to interview questions about how instructors use these sessions to engage students, provide meaningful feedback, and support course navigation or mathematical understanding. These questions helped set the stage for focus group discussions, where students offered their perspectives on course organization, instructor facilitation, and the role of these elements in their success.

Additionally, survey responses regarding the role and effectiveness of collaboration and peer interaction informed the development of student focus group questions about the use of discussion forums and group activities. This alignment between survey insights and focus group discussions ensured a comprehensive exploration of how social and collaborative components influence the learning experience.

Phase 2: Interviews and Focus Group

Following the surveys, one-on-one interviews with instructors and a focus group interview with student participants were conducted to explore the themes and issues identified in the survey responses more deeply. These interviews provided participants with an opportunity to elaborate on their survey answers, clarify uncertainties, and share opinions that may not have been fully captured in the survey format.

The interactive nature of the student focus group discussions allowed participants to exchange viewpoints, engage in dialogue, and collaboratively generate new insights. This dynamic approach fostered a richer understanding of the factors influencing learning experiences in NOL MTH 161, highlighting both shared experiences and unique challenges. Additionally, the focus group discussions offered valuable opportunities to observe areas of consensus or divergence among participants, adding context and nuance to the survey findings.

Instructor Interviews.

Two one-on-one interviews with instructors were conducted on November 19 and November 25, 2024, instead of a focus group discussion as initially planned. One-on-one interviews provided a confidential setting to share detailed observations and recommendations about teaching practices, instructional design, and student engagement in asynchronous online learning. This approach facilitated the collection of in-depth, individualized insights into their experiences with the course.

These interviews explored instructors' perceptions of teaching presence, cognitive presence, and social presence, while also addressing emerging themes identified from the survey data. An Instructor Interview Protocol (see Appendix G – Instructor Interview Protocol) was developed to guide these conversations, ensuring all relevant topics were covered systematically.

Both interviews were conducted via Zoom, allowing instructors to share their perspectives in a confidential setting. With participants' consent, the sessions were recorded and subsequently transcribed for analysis. Each interview lasted approximately 30 minutes, providing ample time for in-depth exploration of instructional practices, challenges, and successes in the asynchronous online environment.

Student Focus Groups.

The student focus group interview was conducted during the first week of December with five students selected based on their survey responses. This discussion provided an opportunity for students to elaborate on their learning experiences, engagement, and satisfaction with the course. The focus group allowed participants to clarify uncertainties and express opinions that may not have been fully captured in the survey. The interactive nature of the discussion facilitated the exchange of viewpoints, allowing students to engage with different perspectives, challenge ideas, and collaboratively generate new insights. This approach offered a deeper exploration of the factors influencing student learning in NOL MTH 161, helping to identify areas of consensus or divergence among participants.

As part of the data triangulation process, documents and artifacts were initially intended to be collected from both instructors and students. These documents would have included course syllabi, course content such as discussions or announcements posted on Canvas, email communications, instructor-generated instructional materials, feedback and comments, reflection journals, or personal records. However, no documents were voluntarily submitted by participants during this phase.

Due to the lack of document submissions, this phase was not implemented as originally planned. As such, no documents were collected or analyzed for triangulation. Despite this, the data gathered from surveys, interviews, and focus groups provided comprehensive insights into the factors influencing student learning experiences in NOL MTH 161. Future studies may revisit the inclusion of document analysis if participants are able to provide relevant materials that support a deeper understanding of the course dynamics.

The original Document Protocol (see Appendix J – Document Protocol) was developed to ensure that any documents provided would be aligned with the study's focus on teaching presence, social presence, and cognitive presence. Any documents submitted would have been anonymized using the pseudonyms established for the study, ensuring confidentiality. However, due to the absence of document submissions, this aspect of data triangulation was not utilized in this study.

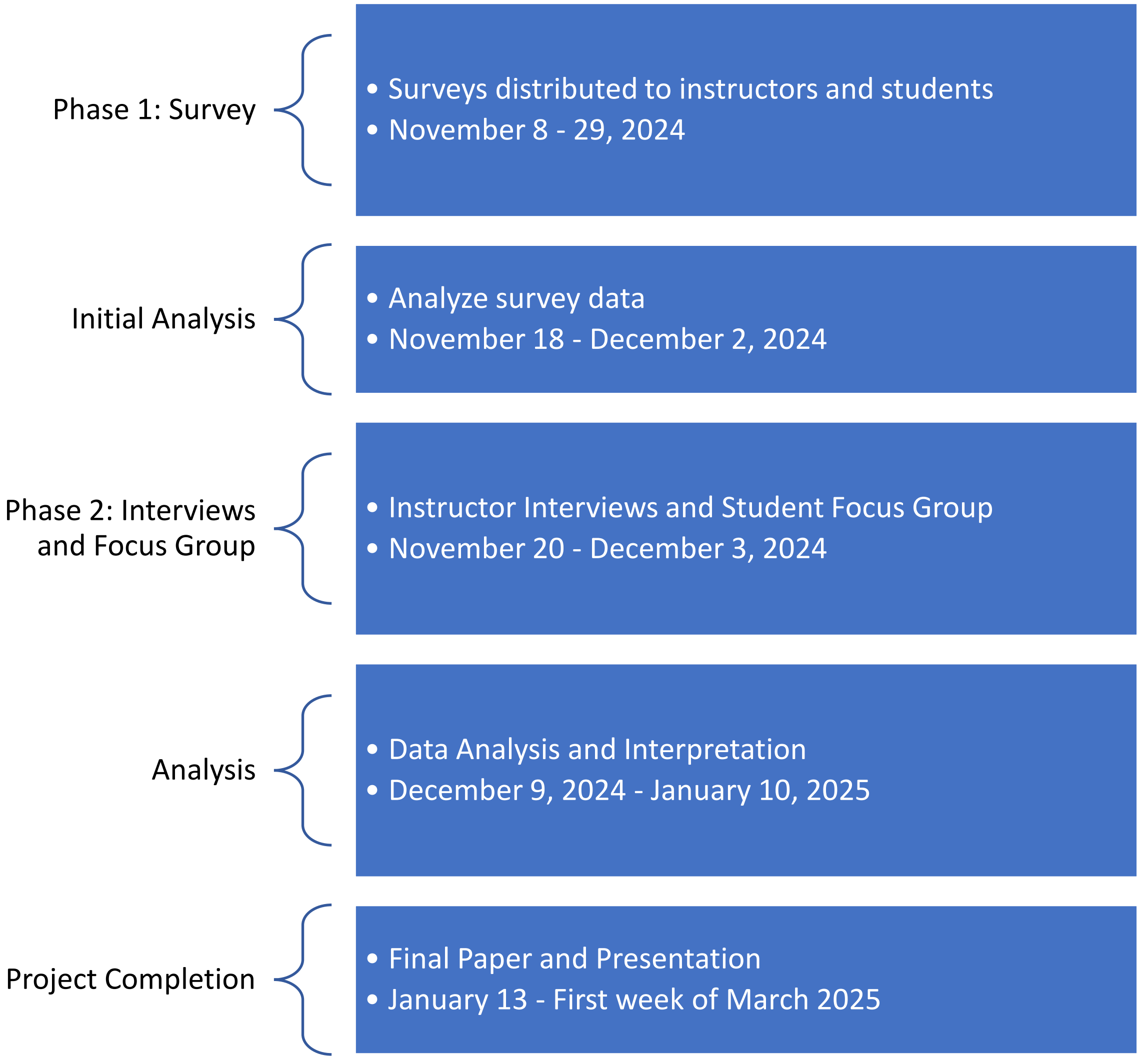
Data Analysis

In case study research, interpreting data from multiple sources is an iterative process involving continual engagement with the data (Hancock et al., 2021). This approach involves repeated examination and interpretation to develop preliminary conclusions and refine research questions over time. To effectively summarize and interpret the research findings, I adhered to the guidelines outlined by Hancock, Algozzine, and Lim (2021). The process involved ongoing refinement of the project's core research questions at each stage of data collection and analysis.

To maintain alignment with the research objectives and avoid being overwhelmed by new qualitative data, only relevant information pertaining to the research focus was interpreted. Data was be organized and stored using the Data Management Tool (DMT; see Appendix H), with Excel used to categorize and manage the large volume of collected data.

The interaction and timing between the phases of data collection and analysis are depicted in Figure 3.1, illustrating how these phases influenced and informed one another throughout the research process.

Figure 3.1: Data Collection and Analysis Timeline



Phase 1: Survey

The Community of Inquiry (CoI) theoretical framework guided the development of a priori codes used in the initial analysis of qualitative survey responses (see Table 3.2). These codes, grounded in literature, align with the constructs of teaching presence, cognitive presence, and social presence. The a priori codes provided an initial structure for analysis, focusing on the study's conceptual framework. Survey data were organized in Microsoft Excel, with responses entered into a Data Segment column for efficient indexing and sorting.

During the initial coding process, passages were categorized using the a priori codes, with overlapping themes coded in duplicate. As the analysis progressed, emergent codes surfaced, reflecting unique challenges and supports specific to NOL MTH 161. These emergent codes expanded the scope of the analysis beyond the initial framework, revealing previously unanticipated factors.

One significant development was the emergence of the Course Presence category. While the CoI framework assumes teaching presence and course design are intertwined, the data revealed that students and instructors often distinguished between the instructor’s actions and the structural or resource-based aspects of the course itself. This distinction led to the creation of a separate category addressing course-specific elements, such as structured content, resource accessibility, and assessment design.

The final coding process refined the initial codes and themes to align with both the a priori framework and emergent insights from the data. This iterative process ensured that the final coding structure reflected participant perspectives comprehensively (see Table 3.3 for the final coding structure). Definitions of each category and theme are available in Appendix K – Codebook.

Table 3.2

A Priori Codes

Construct from Theoretical Framework	Kirkpatrick Levels for Evaluation	Codes Derived from Literature
Teaching Presence	Level 1: Reaction	Instructional Design
		Organization
		Facilitating Discourse
	Level 2: Learning	Direct Instruction
		Assessment and Feedback
		Accessibility and Flexibility
Cognitive Presence	Level 2: Learning	Triggering Event
		Exploration
		Integration
		Resolution
	Level 3: Behavior	Technology Utilization
		Learner Autonomy and Motivation
Social Presence	Level 1: Reaction	Emotional Expression
		Open Communication
		Group Cohesion
	Level 3: Behavior	Open Communication
		Group Cohesion

Table 3.3

Final Codes Categories and Themes

Category	Theme
Course Presence	Structured Content
	Resource Accessibility and Effectiveness
	Assessment Design and Alignment
	Technical Barriers
Teaching Presence	Instructor Support
	Adaptability and Personalization
	Feedback
Cognitive Presence	Problem Solving and Application
	Confidence and Engagement
	Cognitive Overload and Gaps
Social Presence	Peer Collaboration and Resource Sharing
Student Context	Varied Preparedness
	Persistence and Barriers
	Assessment-Related Challenges
External Resources	Tutoring Support
Evaluation Level	Level 1: Reaction
	Level 2: Learning
	Level 3: Application
	Level 4: Outcome
Course Presence	Structured Content
	Resource Accessibility and Effectiveness

Phase 2: Interviews and Focus Group

The interviews and focus group were conducted in November and early December. Survey data guided the selection of participants, identifying those who volunteered, provided detailed feedback, and demonstrated high engagement. This approach ensured that the interviews were grounded in the participants' experiences and perspectives.

The interviews were recorded and transcribed using Zoom. After the interviews, the audio recordings and transcripts were exported and transferred into Excel for analysis, using the same codebook developed and revised in Phase 1. The cut-and-paste method was used to analyze the transcripts, utilizing both a priori and emergent codes from the theoretical and conceptual framework and Phase 1. Content analysis was conducted by examining the frequency of topics, as well as the relative balance of favorable and unfavorable attributions regarding these topics. Additionally, any nonverbal communications, gestures, and behavioral responses not reflected in the transcripts were analyzed from interview notes.

Analytic memos were employed to prevent becoming too focused on the task of coding and to support analytic thinking. In this process, an inductive approach was taken, re-reading the collected data and selecting segments that stood out as interesting. Several of these segments were examined, and writing commenced about what was observed and what questions arose. This analytic memo process continued over time, with questions becoming clearer and easier to target toward the research questions. Analytic memos also identified any gaps in data collection, prompting changes throughout the project. Interview protocol questions that were omitted were edited after reviewing and reflecting on analytic memos. Finally, as the findings and conclusions of the project were reached, insights from the analytic memos were drawn upon, ensuring a comprehensive analysis process.

Document analysis is often used in combination with other qualitative research methods as a means of triangulation (Bowen, 2009). Seeking convergence and corroboration through the use of different data sources and methods, all interview and focus group participants were invited to submit any instructor-generated or student-generated documents or artifacts related to their provided answers in the discussion. Participant names were to be removed to protect their rights and confidentiality. However, no documents or artifacts were submitted for analysis.

Since no document submissions were received, the planned document analysis did not take place. In future iterations of this study, it may be beneficial to refine the document collection process or adjust the timeline to ensure greater participation. Despite this, the interviews and focus group data provided ample qualitative insight into the factors influencing teaching and learning in the course. These sources of data will continue to guide the analysis and interpretation of the findings, which remain robust due to the focus on interview and survey responses.

Trustworthiness

In this subsection, I address four key criteria to ensure the trustworthiness of the study: credibility, transferability, dependability, and confirmability.

Credibility.

The credibility of the qualitative data collected in this study was strengthened through the use of multiple perspectives from both instructors and students. This was achieved through data triangulation, utilizing various sources including surveys, interviews, focus group discussions, and participant validation. Member checks were incorporated during the focus group discussions with both instructors and students, ensuring the accuracy and resonance of the findings. The use of structured data tools such as the document protocols and focus group protocols increased reliability and consistency in data collection. The seven-week duration of data collection and analysis provided sufficient time for building trust with participants and engaging in prolonged interaction, further enhancing the study's credibility.

Transferability.

The goal of this exploratory case study was to achieve transferability rather than generalizability. By providing a “thick description” of the NVCC case, including detailed context about the setting and participants, readers were able to assess whether the findings were applicable to similar contexts. The study collected and presented demographic data from participants, enabling a rich portrayal of the case. These detailed descriptions helped readers determine whether the findings were relevant to other community colleges offering asynchronous online gateway math courses.

Dependability and Confirmability.

Case study findings can be verified and confirmed by sharing the outcomes with participants, other researchers, and experts on the case being studied (Hancock et al., 2021). Detailed notes will be taken to facilitate the assessment of the study’s dependability.

Researcher Positionality and Objectivity.

As a former full-time faculty member at Northern Valley Community College (NVCC) with prior experience teaching NOL MTH 161, I brought a deep understanding of the course’s design, student population, and NVCC Online culture. I had also been involved in course redesign projects, which included supplementing instructional materials and creating assessments. However, since transitioning to a new position at another organization and no longer teaching at NVCC, I was removed from direct involvement with the course. To mitigate any potential bias due to prior affiliation with NVCC, the following steps were taken:

- Adherence to established data collection and analysis protocols.
- Engagement in reflexive practices, with the researcher documenting thoughts, biases, and influences throughout the research process.
- Use of participant validation, where findings were shared with participants for accuracy and alignment with their experience.

These measures ensured that the study was conducted ethically and transparently, maintaining objectivity and minimizing any personal bias.

Ethical Considerations

Ethical considerations are critical in research involving human participants, especially in case study research, where the researcher works closely with participants and the researcher-participant relationship may play an important role in the findings (Roller & Lavrakas, 2015). For this study, approval was obtained from the Institutional Review Board (IRB) for Social and Behavioral Sciences at both the University of Virginia (UVA) and Northern Valley Community College (NVCC). This approval ensured that the research was conducted ethically, and that participants' rights and welfare were protected.

Informed consent was obtained from all interviews and focus group participants by way of their voluntary participation in the study. For survey participants, consent was implied when they began the survey, as they were informed about the study's purpose, procedures, risks, and benefits at the beginning of the survey. Clear, jargon-free language was used, and participants had the opportunity to ask questions before proceeding. Participants were also debriefed at the end of the study to ensure they understood the nature of the research and to address any questions or concerns. They were informed that they could withdraw from the study at any time without consequence.

Data Management

Given the sensitivity of educational data and its potential implications for participants' academic and professional lives, all data files were stored securely on a password-protected Google Drive. Only the researcher had access to the data. Data was retained for the duration of the study and was securely deleted afterward. To ensure privacy and confidentiality, participants were assigned pseudonyms before any dissemination of the data to prevent the disclosure of individual identities. Each participant was also assigned a source ID, which were recorded in a separate document. Please refer to Appendix L for the full Data Management Tool.

Limitations and Delimitations

This study has several methodological limitations. First, the reliance on self-reported data may introduce biases, such as selective memory, telescoping, attribution, or exaggeration. Participants' responses may also be influenced by social desirability bias or memory recall errors.

Second, as an outsider who transitioned to a new position, I lacked direct access to internal resources or support, leading to delays in obtaining approval and accessing the student and instructor populations. Without access to the SIS (Student Information System), I could not track course dropouts and, therefore, could not verify whether all 248 students listed in the sampling frame provided by the NVCC research office were actively enrolled. Although IRB approvals were eventually granted, these delays impacted the timeline and access to the necessary participants and data.

Third, the scissor-and-sort technique used for analyzing interview and focus group data heavily relied on the judgment of a single analyst and potentially introduced subjectivity and bias. Fourth, data collection occurred only in November and early December, meaning student participants were limited to those enrolled in the Fall semester. These students may differ from those in the Spring or Summer semesters. It would be beneficial to replicate the study with Spring or Summer classes, as well as 7-week or 13-week accelerated courses.

Additionally, the sample sizes for interviews and the student focus group were limited due to scheduling constraints, participant availability, and timing around the holiday season. Instructor participation was particularly affected by workload demands; for example, one instructor declined to participate due to teaching overload and grading responsibilities, while another expressed discomfort sharing detailed insights. Similarly, some students who expressed willingness to join the focus group discussion were ultimately unable to participate because of conflicting school and work schedules, as well as holiday commitments. All five focus group participants were passing the course at the time of data collection, which may have led to perspectives that emphasize successful strategies and positive experiences, while potentially underrepresenting the challenges faced by students who struggled or did not complete the course. Additionally, both instructors interviewed had prior experience teaching online courses, which may have limited insights from instructors who are newer to asynchronous instruction or less familiar with the specific demands of an online STEM gateway math course. These factors may have influenced the range of perspectives captured, potentially affecting the overall scope of the findings.

Finally, the generalizability of the findings may be constrained by the specific context of NVCC and its online gateway math course, limiting the extent to which the results can be applied to other educational settings or populations. For example, similar but more advanced courses, such as Calculus, often involve students who have prior experience with online learning or college-level math courses. This difference in student preparedness and familiarity with the subject matter means that the insights gained from this study may not fully translate to courses with more advanced or experienced student populations.

This study also has several delimitations that constrain its scope. First, it focuses on a Precalculus gateway math course delivered asynchronously online, and its findings may not be directly applicable to other gateway math courses, such as Quantitative Reasoning or Calculus I, or to other online math courses that are not considered gateway courses. Second, the study is limited to courses taken by community college students during the Fall semester, and its findings may not be transferable to courses offered in four-year universities or delivered in Spring or Summer semesters. Lastly, this study includes only students who remained enrolled in the course near the withdrawal-without-grade-penalty date, excluding insights from students who dropped out earlier in the semester. Future research could address this gap by exploring the experiences of students who withdraw earlier in the semester.

Conclusion

In conclusion, this study employed a qualitative exploratory case study research design, utilizing protocols and survey questions informed by the literature reviewed in Chapter 2 and the Community of Inquiry (CoI) theoretical framework. The research involved two phases of data collection, including surveys with instructors and students, focus group interviews with student participants and semi-structured interviews with instructor participants. These methods were chosen to collect and analyze a comprehensive understanding of the factors influencing student satisfaction, engagement, and perceived learning outcomes in an asynchronous online gateway math course at NVCC Online. Despite potential limitations, such as bias in self-reported data and reliance on a single researcher for data analysis, efforts were made to ensure the trustworthiness and rigor of the study through data triangulation, member checks, and audit trails. The findings are expected to contribute insights for NVCC Online to improve the outcomes of the asynchronous online MTH 161 course and, more broadly, to the field of community college education, helping to better support students in online gateway math courses.

Chapter 4 Findings

This chapter presents the findings of the study, which investigates factors influencing student learning in NOL MTH 161 Precalculus I, an asynchronous online STEM gateway math course at NVCC. The study explored two research questions:

1. What factors do instructors perceive as supporting or hindering student learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?
2. What factors do students perceive as supporting or hindering their learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

To address these questions, the study employed a conceptual framework focusing on the interaction of teaching presence, cognitive presence, and social presence to facilitate learning in an asynchronous gateway math course. The framework emphasizes the instructor's pivotal role in fostering engagement by organizing content, providing timely feedback, and connecting students to resources, all aimed at enhancing cognitive engagement and supporting novice online learners. It also highlights the importance of peer collaboration in fostering active participation and deeper understanding of mathematical concepts.

Data were collected through surveys of instructors and students, two semi-structured instructor interviews, and a focus group discussion with five students. Quantitative survey data were analyzed descriptively, while qualitative data were thematically analyzed to identify recurring patterns and insights. Triangulating data from student and instructor surveys, a focus group, and interviews offered varied perspectives on the factors influencing the student experience and learning outcomes in the course.

Table 4.1 provides a summary of the interview and focus group participants, including their roles and relevant background information.

Table 4.1

Semi-Structured Interview and Focus Group Participants

Instructor Participant Profiles	
Rachel Monroe	Professor Rachel is a full-time math instructor at the Oakwood Campus. Relatively new to NVCC, she has experience teaching developmental and gateway math courses. Currently, she teaches most classes in person and is in her second term teaching NOL MTH 161.
Maria Garcia	Professor Maria has been teaching at NVCC for 15 years. She specializes in teaching MTH 161 Precalculus and MTH 261 Applied Calculus I, giving her insight into the skills needed for student success in subsequent courses. She has also taken on leadership roles at the Fairview Campus.
Student Participant Profiles	
Aaliyah Johnson	Aaliyah is a sophomore majoring in Information Technology. After completing MTH 154, she enrolled in NOL MTH 161 with a previously successful instructor. She is taking a mix of in-person and online courses.
Abdul Rahman	Abdul is a freshman in the online Information Technology program. He relies on tutoring and external resources for support, finds the course workload inconsistent, and struggles with time-constrained exams.
Ethan Brooks	Ethan is a freshman studying Business Administration while balancing a part-time job and online coursework. He values instructor feedback but finds strict deadlines challenging and misses in-person support.
Diego Martinez	Diego took NOL MTH 161 based on positive professor reviews. While math isn’t his strongest subject, he felt prepared for the next course. Diego values informal peer interactions but finds aspects of online learning stressful and confusing. His goal is to transfer to George Mason.
Sofia Lee	Sofia found NOL MTH 161 manageable due to her prior precalculus experience in high school. She relied heavily on ALEKS for independent study and appreciated its immediate feedback. After her success in the course, she plans to take calculus through NVCC Online.

Table 4.2 presents a summary of the data collection methods utilized in this study, specifying the number of interviews and surveys conducted, along with a brief overview of the data captured.

Table 4.2

Summary of Data Collection Methods

Type	Source	Number of Data Points	Data Captured
Survey	Students	19 responses from 248 invited students (8% response rate)	Likert-scale ratings on Community of Inquiry items, course evaluation items, and open-ended responses for suggestions and feedback
Survey	Instructors	6 responses from 7 invited instructors (86% response rate)	Likert-scale ratings on Community of Inquiry items, course evaluation items, and open-ended responses for suggestions and feedback
Focus Group	Students	5 participants	Perceptions of challenges and support
Semi-structured Interview	Instructors	2 participants	Perceptions of challenges and support
Document Review	Course Syllabus	1 syllabus reviewed	Course structure

The findings are structured around the key components of the conceptual framework. Finding 1 examines what online learners bring to the course and how their preparedness impacts their learning experience during the early stages. Finding 2 highlights course presence as a distinct category in the data, reflecting how students and instructors perceive the course itself—independent of the instructor’s actions—and its interaction with cognitive presence. Finding 3 explores social presence, emphasizing the role and effectiveness of discussion board activities.

Finally, Finding 4 focuses on instructor presence, exploring how instructors facilitate learning and provide support to help students achieve success. Below is a summary of the four findings:

- **Finding 1**: Varying levels of mathematical preparedness and readiness for college-level coursework shaped students' initial experiences, influencing their ability to adapt and persist in the course.
- **Finding 2**: While the syllabus and organizational framework provided clarity for many, the rigidity of the course structure and challenges with assessments created significant barriers, limiting students' ability to adapt and demonstrate mastery effectively.
    - **Sub-finding 2.1:** The structured course design supported navigation but constrained adaptability.
    - **Sub-finding 2.2:** Assessments emerged as a significant concern, identified by both instructors and students.
- **Finding 3**: Mixed perceptions of peer learning and social presence revealed the benefits of resource sharing, but also highlighted limitations in collaborative activities for supporting deeper mathematical understanding.
- **Finding 4**: Instructor presence, characterized by accessibility, responsiveness, and proactive engagement, positively influenced student experiences and outcomes, though gaps in personalization and effective utilization of feedback limited its overall impact.
    - **Sub-finding 4.1**: Instructor availability and proactive communication fostered engagement and supported student success.
    - **Sub-finding 4.2**: Limited personalization and underutilization of feedback hindered learning outcomes.

These findings illustrate how student context, course structure, and the dimensions of teaching (both course and instructor), cognitive, and social presence interact to shape experiences, learning, and outcomes. They provide a foundation for actionable recommendations aimed at enhancing teaching and learning in asynchronous gateway math courses. The remainder of this chapter elaborates on each finding, providing detailed analysis and evidence to inform future improvements.

Finding 1: Varying levels of mathematical preparedness and readiness for college-level coursework shaped students' initial experiences, influencing their ability to adapt and persist in the course.

Finding 1 addresses both Research Questions 1 and 2, highlighting factors identified by instructors and students as influencing learning in NOL MTH 161. It illustrates how varying levels of mathematical preparedness, readiness for college-level coursework, and individual expectations shaped students' early experiences and learning outcomes. Students' initial struggles highlighted common barriers and the persistence strategies they described in navigating the independent, asynchronous environment.

Survey data provided insight into the student population: 74% were full-time students and 26% part-time. Students came from a range of backgrounds and experiences, as reflected in open-ended survey responses and a focus group discussion. The group included a 67-year-old non-traditional student retaking the course for the fifth time, an 18-year-old recent high school graduate navigating their first college course, a working parent balancing studies with family responsibilities, and an experienced NVCC student taking the course as a second math to change majors.

Students also differed in their comfort with technology, approaches to learning mathematics, and expectations regarding opportunities to retake exams as a way to improve grades and demonstrate mastery. Some students skillfully connected prior knowledge to course goals by leveraging available resources, while others required more structured guidance and scaffolded support to succeed. Students' responses reflected a range of outcomes, with some completing the course and others planning to withdraw and retake it in a different modality.

This section is organized around two key subthemes within the broader theme of student context and its impact on their experience and learning in NOL MTH 161: their varying levels of preparedness and the barriers they faced alongside the persistence strategies they employed.

Varying Levels of Preparedness

Descriptive survey findings highlighted notable variability in students' preparedness for the demands of NOL MTH 161. Students responded to two survey questions related to their preparedness for the course: 'How ready did you feel to take an online course?' and 'How ready did you feel to take MTH 161 Precalculus I?' Responses were analyzed by grouping the top two and bottom two categories to calculate percentages. Fewer than half (42%) of student respondents reported feeling ready or very ready for asynchronous learning, while an even smaller percentage (37%) felt prepared for the mathematical rigor of the precalculus course (Figures 4.1 and 4.2). Conversely, 37% of students reported feeling unprepared or minimally prepared to learn precalculus concepts, and 21% explicitly indicated that they were not ready at all or minimally ready for the challenges of an online asynchronous format. While quantitative data on instructor perceptions of student preparedness was not collected, the theme of varying levels of preparedness emerged prominently in instructor survey comments and interviews with two instructors.

Figure 4.1

Perceived Online Learning Readiness

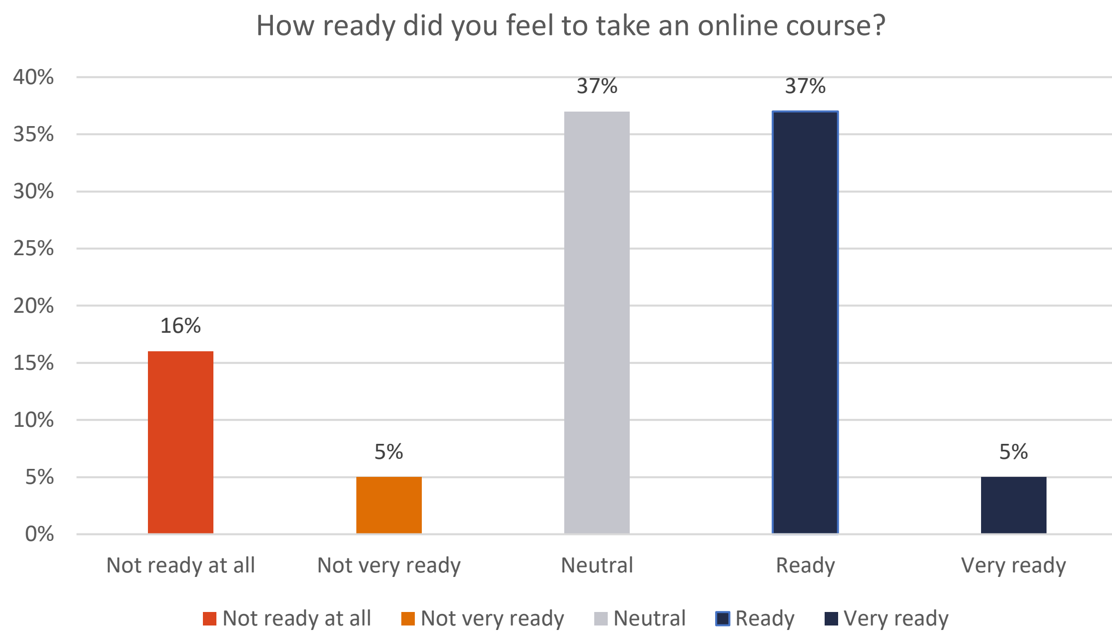
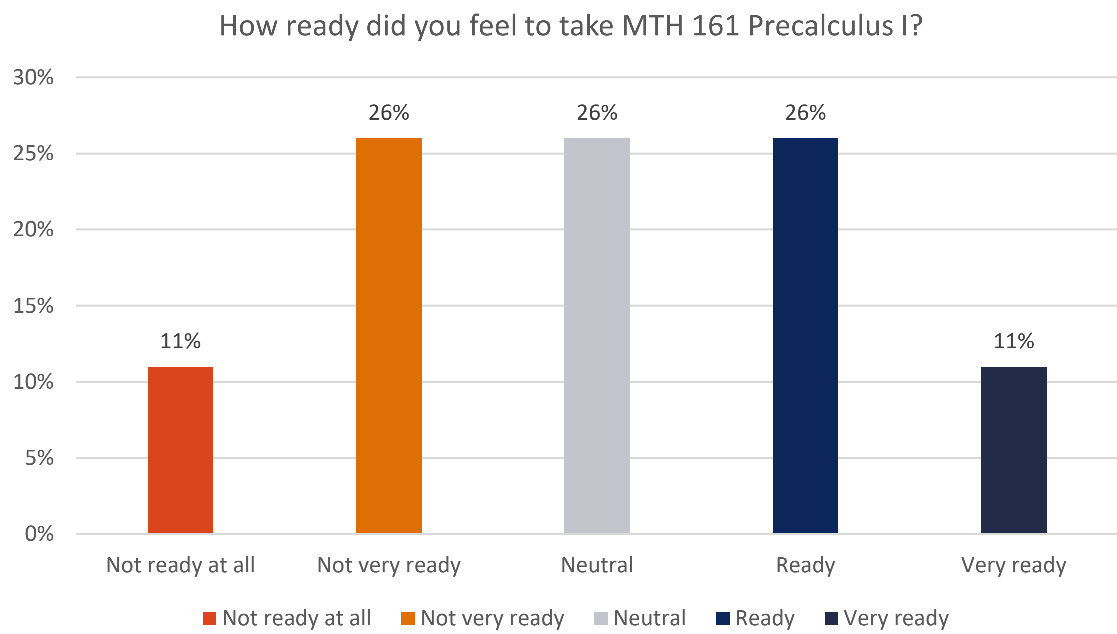


Figure 4.2

Perceived Math Readiness



It is important to note that these surveys were conducted in November, well into the semester, after students had experienced the coursework and its expectations. This timing suggests that students' perceptions of preparedness may have evolved as they encountered the realities of the course. Additionally, the timing likely reflects the perspectives of students who persisted, as those who initially placed but withdrew may have faced even greater challenges in preparedness. These findings highlight the variation in students' starting points, with some entering the course with strong foundations and confidence, while others faced significant gaps in mathematical knowledge and readiness for asynchronous, independent learning.

Qualitative findings further highlight the significant variability in students' preparedness levels and backgrounds, as well as its impact on their learning and experiences. One non-traditional student highlighted the difficulty of reacquainting themselves with advanced mathematical concepts after a decades-long gap, sharing:

> I graduated high school 50 years ago without taking advanced algebra or trigonometry but now I need to learn them to take a programming course. As a mature student, I've really struggled to learn how to learn math all over again. My day job is law professor, and I scored something like the 97th percentile on math on SAT 50 years ago, but not having studied or used math for decades, I've been shocked by how hard it's been. (Survey_students, QID11_R2)

This response provides an example of how non-traditional students, despite previous academic achievements, describe challenges in reengaging with advanced mathematics. Their experience highlights how gaps in preparedness can create barriers not only to mastering the mathematical content but also to adapting to the independent demands of asynchronous learning.

In contrast, students with recent exposure to precalculus concepts experienced a smoother transition. Sofia, a recent high school graduate, shared during the focus group:

> I took precalculus in high school, so this class felt more like a review for me. There were some new topics to learn, but a lot of it was familiar, which made it easier to follow and helped me feel prepared for calculus. (Focus Group, para. 1)

Sofia's experience illustrates how her strong prior preparation in math eased her transition into NOL MTH 161, despite it being her first semester at NVCC. This foundation enabled her to navigate the course effectively, highlighting the impact of prior preparation on students' ability to adapt and perform in an online learning environment.

Another student, Aaliyah, offered a unique perspective during the focus group, sharing her experience of taking MTH 161 as a second math course after switching programs:

> I already knew my professor from another class, I took [MTH] 154 [Quantitative Reasoning] with her and switched major and needed another math class… Precalc is

> definitely harder than MATH 154, but I still found it manageable. This was my first online class, and I struggled a bit, but knowing my professor really helped. (Focus Group, para. 4, 14)

Aaliyah's comment highlights how familiarity with an instructor, even from a prior course in a different format, can provide a sense of continuity and support. Successfully passing another college-level math course—even if it was not directly related to precalculus—further bolstered her confidence and readiness for NOL MTH 161.

Instructors of NOL MTH 161 emphasized the importance of both mathematical preparedness and readiness for college-level coursework as key factors shaping student experiences and outcomes. One instructor noted in a survey, "The course design is effective for students who are prepared and understand the expectations of college" (Survey_instructors, QID50_R1). In a semi-structured interview, Professor Rachel elaborated on how the fast-paced nature of the course presents unique challenges for students with varying levels of preparedness. She explained:

> Whether they're coming straight from high school or developmental math, this course moves much faster than they're used to, especially for those who want to take it online. For some, it's a steep learning curve. I've had students who really struggle with the basics, and I often suggest they consider retaking the course with MDE 61 support [Math Direct Enrollment 61: Learning Support for Pre-Calculus, a corequisite course for in-person sections for MTH 161, not currently offered for NOL MTH 161 students] in a traditional classroom setting. But they insist on staying in the online class because it suits their schedules better. (Interview 1, para. 22)

Professor Rachel described challenges for students lacking prerequisite skills, particularly in the fast-paced and self-directed format of NOL MTH 161. In a separate semi-structured interview, Professor Maria, another instructor of NOL MTH 161, emphasized the importance of students entering the course with a solid foundation:

> I see success in students who come into the class with a solid foundation in prerequisites. If they're willing to put in the time and effort, they thrive in this class. They really need to come in prepared for college-level precalculus… I make it clear at the start of the semester that my role is to facilitate their learning as a guide, not to teach them directly—there are no Zoom lectures or live sessions in this course. (Interview 2, para. 4)

Professor Maria highlighted the importance of readiness and effort for success in the course, particularly for students with limited foundational preparation. Additionally, Professor Maria offered insights into the challenges posed by self-placement policies, along with recommendations for improvement:

> One of the biggest challenges I see is with self-placement. Some students sign up for this class without fully understanding what's required, and they end up struggling with both math and workload. Advisors need to help students determine if this modality is right for them. I've seen students waste weeks before realizing they would benefit more from in-person instruction. (Interview 2, para. 14)

Professor Maria noted challenges with self-placement, describing how some students struggle early in the semester without adequate preparation. Without adequate advising or preparation, some students find themselves unprepared for the demands of NOL MTH 161, leaving them at a disadvantage. However, these students are not necessarily doomed. For those who choose to persist, the challenges they face become opportunities to adapt and develop new strategies for success.

The next subsection explores these barriers and persistence strategies in greater depth, examining the struggles students encountered and the factors that enabled them to overcome obstacles and achieve their goals.

Barriers and Persistence Strategies

In NOL MTH 161, instructional materials—including pacing guides, weekly homework assignments, module quizzes, and exams—are standardized through a course template replicated across sections and instructors. The course uses ALEKS, an online learning and assessment platform, to assign weekly homework and quizzes aligned with course objectives. While ALEKS offers adaptive learning features, NOL MTH 161 currently employs non-adaptive, textbook-based static homework and quizzes to ensure that all students work on the same questions for both assignments and assessments.

Descriptive statistics from surveys revealed that 100% of instructors and 75% of students believed the syllabus clearly explained course goals and expectations (see Table 4.3, Figures 4.3, and 4.4). Despite this alignment on the syllabus, many students reported significant challenges in adapting to the demands of an independent, asynchronous learning environment. Key barriers included a lack of real-time interaction with instructors, difficulties in maintaining self-motivation, and the fast-paced structure of the course.

One prominent barrier was the disconnect between students' expectations for real-time instructor support and the reality of the asynchronous course design. While many students chose the asynchronous format for its flexibility, frustrations about the lack of immediate interaction with instructors surfaced in both student surveys and focus group discussions. While instructors teach the course, they do not design the instructional materials or course structure. This distinction may explain why their feedback on course content and design is not consistently favorable.

Table 4.3

Course Content and Design Summary Table

Course Content and Design (% Favorable)	Students	Instructors
The instructional materials help students understand mathematical concepts.	53%	50%
Canvas modules are well-organized and easy to follow.	63%	33%
The syllabus clearly explains the course goals and expectations.	75%	100%
The quizzes and exams accurately assess student learning.	42%	17%

Figure 4.3

Course Content and Design Breakdown (Instructor Feedback)

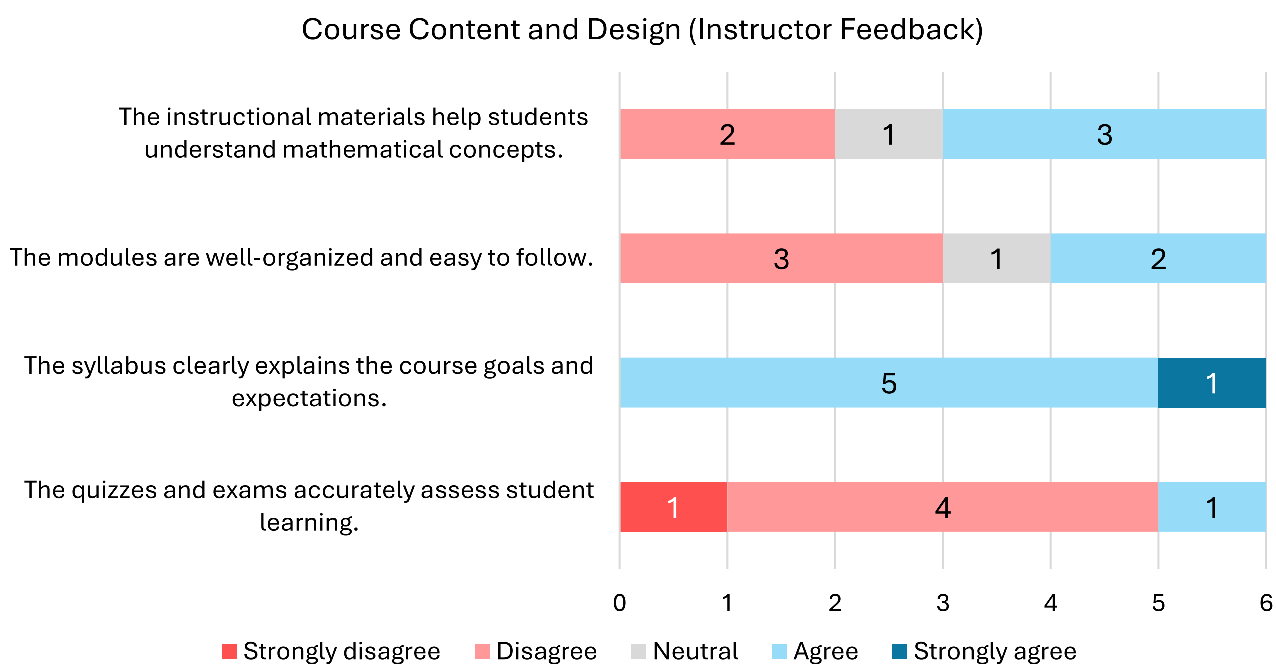
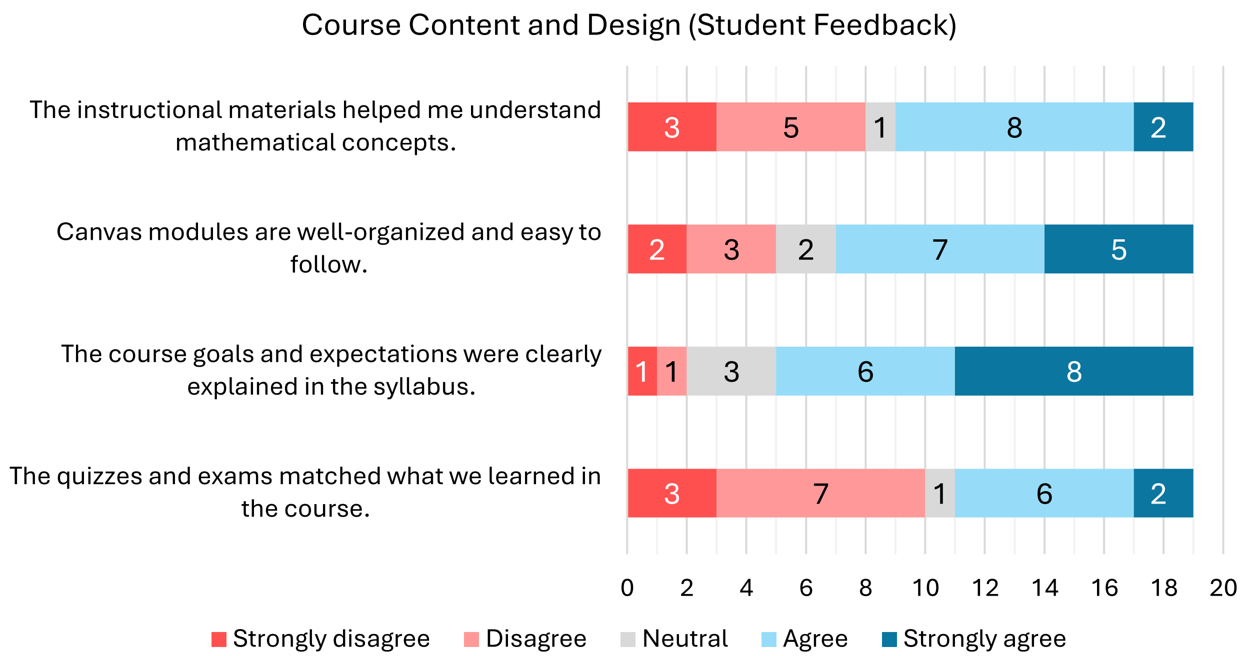


Figure 4.4

Course Content and Design Breakdown (Student Feedback)



Several students highlighted these barriers in the survey, particularly in response to the open-ended question, "What specific aspects of this course made it more challenging for you?" One student shared, "The most challenging aspect of the course was the lack of immediate help from the professor. Sometimes lack of help due to confusion parts" (Survey_students, QID11_R1). Another echoed, "I wish I had a teacher helping me with examples" (Survey_students, QID11_R9). A third elaborated:

> One thing that made this class challenging was not having the help when I got stuck. I couldn't figure out a few of the problems on solving systems of equations on my own and ALEKS explanation didn't make sense, so I emailed my professor and had to wait for an email response, which slowed me down. (Survey_students, QID11_R11)

While 83% of instructors and 63% of students agreed in the survey that instructor feedback is often or always timely, a disconnect remains between these perceptions and some students' need for immediate, just-in-time support. The NOL MTH 161 syllabus specifies a grading turnaround of no later than seven days after the due date, with efforts to provide feedback sooner when possible, and instructors typically adhere to a 48-hour email response policy. Despite these established timelines and the overall perception of timely grading feedback, some students expressed frustration with the lack of real-time assistance when actively working to grasp material.

Students employed various strategies to address these barriers, including reaching out to instructors more regularly, seeking external resources, and leveraging technology tools for problem-solving. One key avenue for synchronous support in NOL MTH 161 is through "student engagement hours," previously referred to as "office hours." The term was updated at NVCC to address misconceptions some students had about "office hours," which led to underutilization of this resource. However, survey results revealed a significant gap in the utilization of these hours in NOL MTH 161. While 83% of instructors indicated they offered engagement hours to provide additional support, only 47% of students reported accessing or utilizing these opportunities (see Table 4.4, Figures 4.5, and 4.6).

Table 4.4

Instructor Facilitation Summary Table

Instructor Facilitation	Students	Instructors
Post weekly announcements to help stay on track	79%	100%
Send reminder emails about upcoming deadlines	47%	67%
Create and/or share supplemental instructional materials to enhance understanding.	58%	83%
Offer office hours to provide additional support	47%	83%
Organize review sessions to reinforce learning	26%	17%
Feedback is timely	63%	83%
Feedback is helpful	37%	-

Figure 4.5

Instructor Facilitation Breakdown (Instructor Feedback)

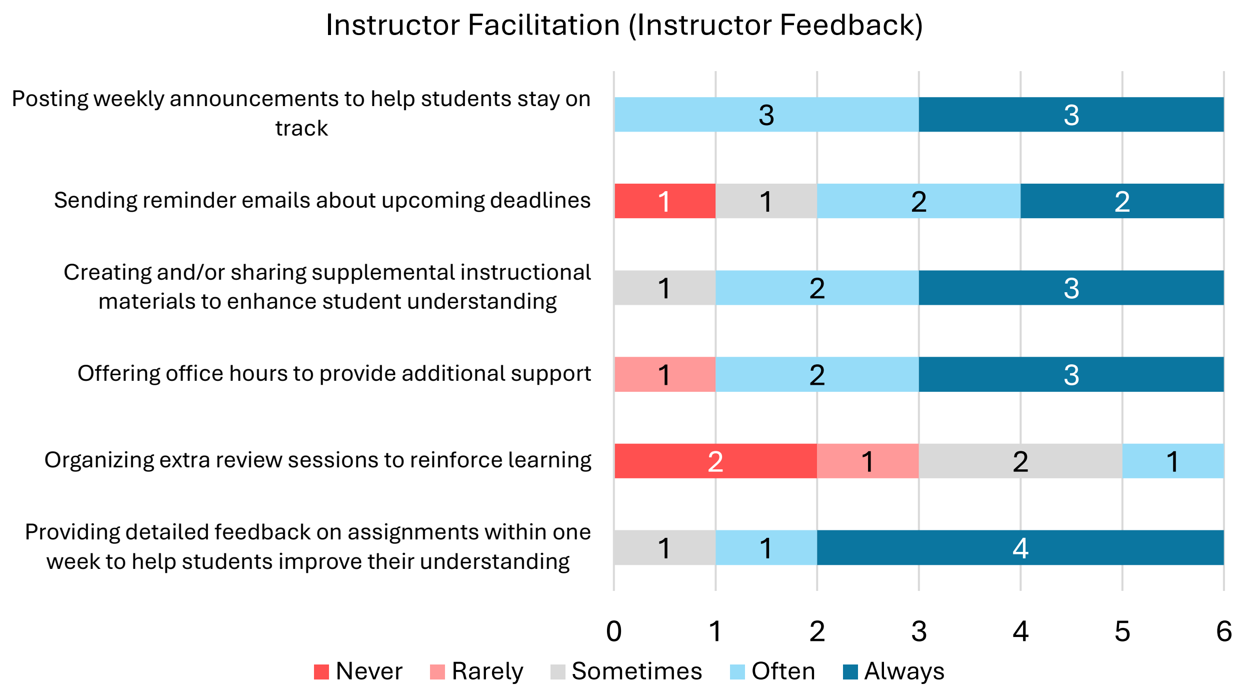
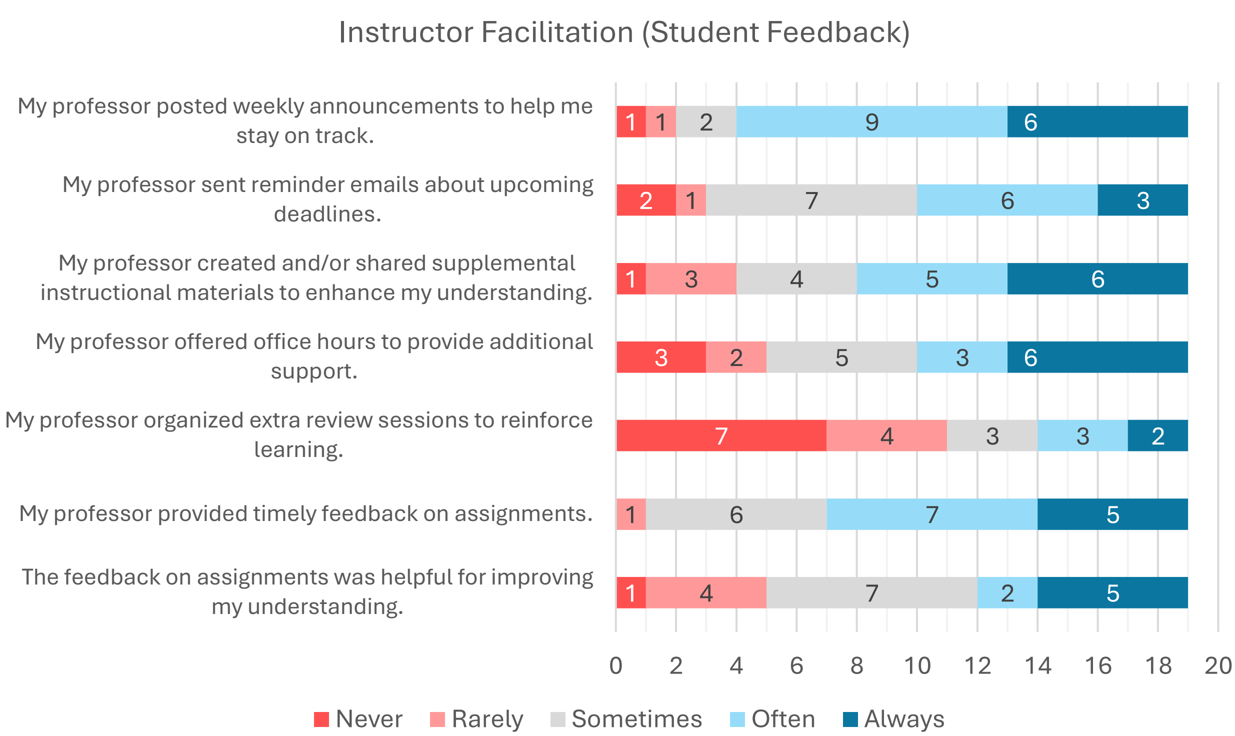


Figure 4.6

Instructor Facilitation Breakdown (Student Feedback)



Although the survey did not include a follow-up question to explore why students were not utilizing office hours for synchronous support, qualitative insights provided further context. In response to the survey question, “Based on your observation of student performance and engagement, what aspects of this course made it harder for students to succeed?”, one instructor observed, “some students attempted to use office hours but were often preoccupied with other responsibilities, making it difficult for them to manage their time and meet deadlines” (Survey_instructors, QID49_R2). Similarly, in a focus group, Aaliyah shared her challenges in meeting with her instructor, despite acknowledging that it was the most effective way for her to receive the support she needed:

> There were some weeks I couldn’t meet with my professor, and when I tried the tutoring center, it wasn’t very helpful. I needed my professor to explain the material to me, but sometimes it was hard to connect with her when I needed her help to review for an exam. (Focus Group, para. 10)

Another anonymous student expressed frustration over the perceived lack of instructor availability:

> In the beginning I has asked my professor what his office hours are and if he would be available to meet. His response was that I should transfer to an in-person classroom. I completely understand that I choose an online class, but I was expecting to have some support from the professor, as I have had in the past with other online courses. Next time I will be sure to do in person since I was unable to get help from my professor outside of email. (Survey_students, QID11_R6)

These concerns highlight differing expectations among students about the level of support in asynchronous courses, which may influence their engagement and success. These barriers reflect the challenges students face in balancing independent learning with the need for timely support.

Another recurring barrier was maintaining self-motivation and pacing within the independent learning modules. Survey results indicated that only 47% of students agreed the course activities kept them interested and engaged (see Table 4.5 and Figure 4.7). One student shared, “I’ve never really found math to be the most interesting subject, so my main challenge was just staying focused” (Survey_students, QID11_R4), underscoring how a lack of interest in the subject area can directly impact engagement. Similarly, an instructor observed “Students struggle with maintaining self-motivation and adapting to the varied learning paces supported by ALEKS” (Survey_instructors, QID49_R3).

The fast-paced structure of the course was another recurring theme. One student described in the survey:

> It felt like we didn’t have enough time to really get one topic before jumping to the next. For example, the week we did log functions, I was struggling to keep up with the ALEKS homework and the discussion board, and that messed me up on the quiz. (Survey_students, QID11_R3)

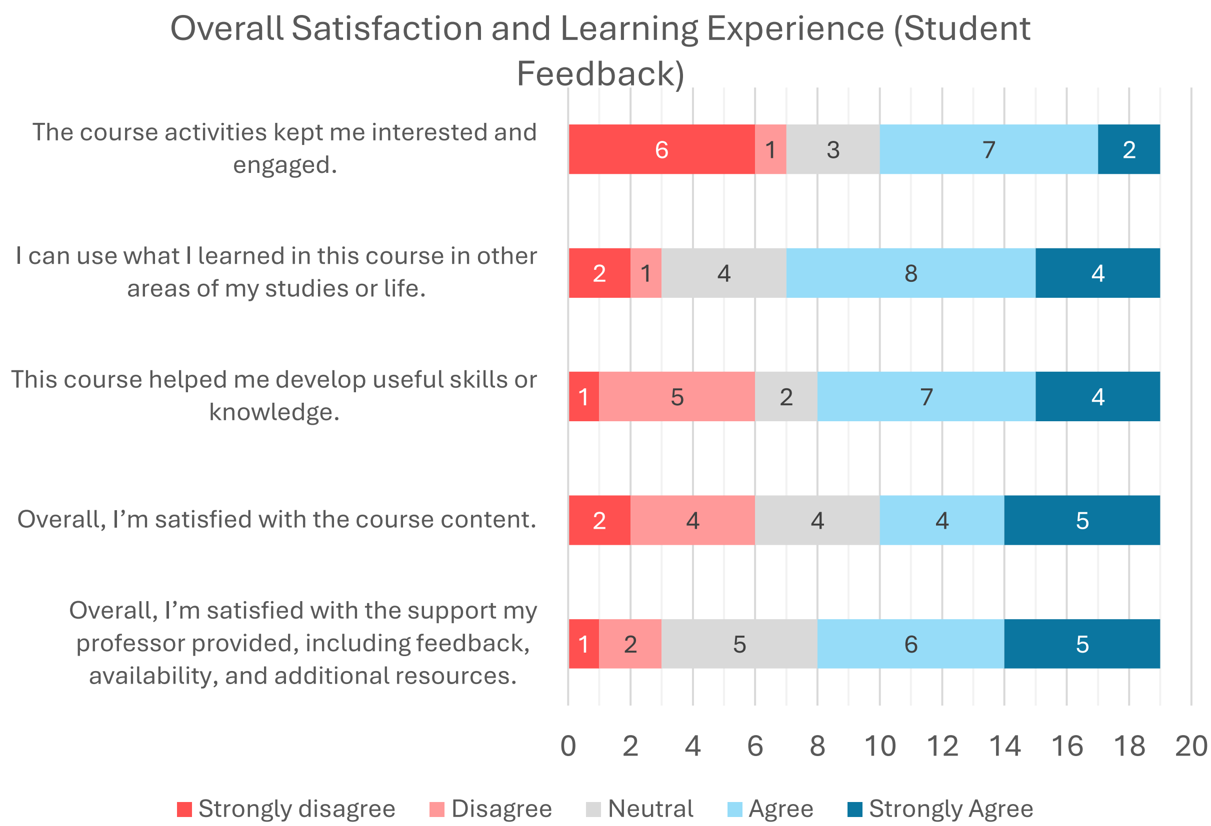
Table 4.5

Overall Satisfaction and Learning Experience Summary Table

Overall Satisfaction & Learning Experience	% Favorable
The course activities kept me interested and engaged.	47%
I can use what I learned in this course in other areas of my studies or life.	63%
This course helped me develop useful skills or knowledge.	58%
Overall, I’m satisfied with the course content.	47%

Figure 4.7

Overall Satisfaction and Learning Experience (Student Feedback)



At the time of data collection, students were tackling some of the most challenging units of the course, which required applying complex mathematical concepts to new problems. Survey responses and interview comments frequently highlighted the difficulties students faced in these later modules, compounded by the fast-paced nature of the course. For students who fell behind, gaps in understanding accumulated, making it even harder to catch up as the course progressed. This challenge was particularly evident in the final units, as Professor Maria explained:

> When students fall behind, those learning gaps really start to pile up. For example, if they can't use logarithmic properties, they're going to struggle to solve log equations. If they

> can't convert exponential equations into log form, they're stuck. Can't solve exponential application problems. (Interview 2, para. 10)

For some students, these barriers ultimately led to withdrawal, as one shared, "This course was difficult, and I plan to withdraw" (Survey_students, QID11_R6). Others, however, adapted and developed strategies to persist. Professor Rachel reflected on how Exam 1 often served as a pivotal moment for students: "I often hear from a range of students after Exam 1. It's a real wake-up call for many… exam highlights different needs, from building foundational skills to refining strategies for top performance." (Interview 1, para. 3)

Students who persisted employed various strategies to overcome challenges, including seeking external support, leveraging technology tools, and refining their study habits. Abdul shared, "I mostly worked with my tutor, who helped me solve problems and explained things I didn't understand" (Focus Group, para. 28). Diego, on the other hand, relied on technology tools, stating, "I used ChatGPT and Photomath for studying. I use them to see steps" (Focus Group, para. 27). No instructors or other student participants in the study mentioned using mobile apps or AI-powered calculators as learning tools.

The next section explores how the course's design supported clarity and navigation for some students while discussing challenges with assessments and structural rigidity that hindered effective demonstration of mathematical understanding.

Finding 2: While the syllabus and organizational framework provided clarity for many, the rigidity of the course structure and challenges with assessments created significant barriers, limiting students' ability to adapt and demonstrate mastery effectively.

Finding 2 addresses both Research Questions 1 and 2, examining how different elements of course design and assessments both supported and or hindered student learning in NOL MTH

161 Precalculus I. Instructors identified the structured, pre-designed Canvas course template as both a strength and a limitation (RQ1). Similarly, students expressed mixed perceptions of the course design and policies, noting that they sometimes supported learning but could also hinder it (RQ2).

The data suggested a distinction between elements actively shaped by instructors (instructor presence) and those dictated by the fixed design of the course (course presence). This finding explores the interaction between course presence, cognitive presence, student learning, and overall experiences. While students reported that the structured course design, including well-organized instructional materials and formative assessments, aided their ability to stay organized and engaged, instructors and students reported that the fixed pacing and content sequencing created challenges in adapting to unexpected difficulties.

Sub-finding 2.1 examines how the structured course design supported students' organization and engagement, fostering cognitive presence through well-organized instructional materials and formative assessments designed to encourage knowledge exploration. Sub-finding 2.2 focuses on assessments, which consistently emerged as a significant challenge for students, as identified by both students and instructors.

Course Structure: Support and Limitations

The NOL MTH 161 Course Syllabus (Appendix M) is a public document accessible to all students and was reviewed to provide context for the findings. The syllabus outlines key information, including the course description, objectives, time expectations, technical requirements, grading policies, assignments, and student resources. Instructors are expected to customize certain policies, such as attendance and late work policies. The course begins with a syllabus quiz in Canvas, which ensures students understand the course structure and rules.

One noteworthy section of the syllabus focuses on Time Expectations, emphasizing the importance of consistent progress for distance education success. It provides students with a guide on weekly study hours based on course length and credits. For instance, students taking a 15-week, 3-credit course are advised to allocate 6–9 hours per week for study. The syllabus also stresses the importance of adhering to assignment schedules and completing one task at a time to stay on track.

Descriptive survey data revealed mixed perceptions of the course structure. The syllabus was widely regarded as clear, with 100% of instructors and 74% of students agreeing it effectively communicated goals and expectations (See Figure 4.3). Similarly, approximately half of both groups (53% of students and 50% of instructors) agreed that the instructional materials effectively supported mathematical understanding. However, there was a notable difference in how students and instructors viewed the organization and effectiveness of the Canvas modules. While 63% of students agreed or strongly agreed that the Canvas modules were well-organized and easy to follow, only 33% of instructors shared this view.

The structured design of the course emerged as a key factor in supporting student learning, according to students' feedback. In response to the student survey question, 'What specific aspects of this course (such as assignments, resources, course design, policies, interactions with the instructor and peers, or any other elements) contributed to a successful experience for you? Please share any moments or examples where these made a positive difference for you,' several students praised the clarity and organization of the Canvas modules and weekly homework schedules, which provided a consistent framework for navigating the course. One student simply shared, "The online modules" (Survey_students, QID10_R1), while another elaborated, "The Canvas online modules are helpful. The clear and organized structure of the course made a big difference for me. The weekly modules with detailed instructions and deadlines helped me stay on track" (Survey_students, QID10_R3). Another student highlighted the role of scheduling, stating, "Homework was scheduled every week. Quizzes to review the homework were scheduled regularly" (Survey_students, QID10_R5). While the response did not explicitly mention how these elements supported learning, it was provided in the context of factors contributing to a successful experience.

These structural elements offered clear schedules and organized modules, which some novice online learners noted as helpful in navigating the course and managing self-directed learning. Structured learning modules included activities that introduced problems and encouraged exploration, supporting cognitive engagement. Instructors were asked a similar question in the instructor survey, and one instructor recognized the benefits of the course's structured design in facilitating navigation and resource accessibility. One instructor shared in the survey:

> I think the course itself is very well organized and structured in a way that allows students to access multiple resources if needed. Policies are clear, and expectations are well communicated in the syllabus and through Canvas announcements at the beginning of the course. (Survey_instructors, QID48_R2)

However, challenges emerged regarding the sequencing of mathematical content and the rigidity of the course structure. Some instructors expressed concerns about the progression of problems, noting a lack of a gradual learning curve. One instructor commented in the survey, "It seems to jump right into the more difficult type of problems for each concept" (Survey_instructors, QID50_R4).

Students echoed these concerns, highlighting struggles with pacing in their survey responses. When asked, “What specific aspects of this course (such as assignments, resources, course design policies, interactions with the instructor and peers, or any other elements) made it more challenging for you? Please describe any moments or examples where these factors led to difficulties or negative outcomes,” one student shared:

> Another thing I found hard was how fast the course moved. It felt like we barely had time to understand one topic before jumping into the next. Like, the week we did logarithmic functions, I was struggling to keep up with the ALEKS work and practice problems, and it really hurt my grade on the quiz. (Survey_students, QID11_R3)

In the focus group discussion, Abdul elaborated on the inconsistency in pacing:

> Some weeks, the class moved too slowly, but other times, we had too many topics and assignments all at once. Those weeks were tough, and I wish the workload was more balanced. There were also some topics I just didn’t get as easily, and I needed more time and help with those. (Focus Group, para. 22)

Another student reflected in the survey on the overwhelming workload, stating, “The fast pace of the course was a challenge. It felt like there wasn’t enough time to fully grasp one topic before moving on to the next” (Survey_students, QID11_R3). For students encountering complex topics for the first time, these challenges added to the difficulty of navigating the course. In traditional classroom settings, instructors get to adjust their teaching strategies to address such difficulties. However, in NOL MTH 161, instructors expressed frustration over their inability to adapt the pacing or modify content due to the rigid course structure. As Professor Rachel explained:

> I feel like my students who are taking in-person classes are much more successful. As instructors, we have no control over the lesson structure and are tied to the fixed pacing of the course. This is very different from my in-person sections of MTH 161, where I have the flexibility to decide which topics to focus on more or skip entirely. That flexibility lets me prioritize what students truly need to succeed in calculus. (Interview_1, para. 30)

This rigidity limited instructors' ability to adapt their teaching strategies, which some noted as a challenge in supporting student learning. While the course syllabus allows instructors to set their own late work policies, assignments in ALEKS are programmed to automatically assign zeros for missed deadlines and lock students out from completing past-due homework. One instructor highlighted this challenge in the survey, stating, "The strict no-late-work policy and automatic zeros for late homework discouraged many students, particularly those who fell behind early on" (Survey_instructors, QID49_R2). Ethan, a student in the focus group, shared his frustration:

> My professor told me he couldn't do anything about some of the course policies in the syllabus, which was pretty frustrating. There were times I really wished I could just go to his office and talk with him in person and explain what was going on. (Focus Group, para. 19)

While the structured course design provided clarity and consistency, instructors noted that it limited their autonomy to address students' specific challenges. These constraints hindered the potential for more tailored and effective mathematical learning experiences.

Ethan's experience highlights two key challenges: rigid course policies that restricted instructor flexibility and the absence of informal, in-person interactions that could have provided additional support and guidance when needed. These barriers illustrate the structural limitations of the online format and course design. One notable area where these limitations became especially evident was in assessments, particularly exams, which posed significant challenges for both students and instructors. These challenges will be explored further in the next subsection.

Challenges with Assessment and Policies

A majority of students (53%) strongly disagreed or disagreed that the quizzes and exams matched what they learned in the course, while 83% of instructors expressed dissatisfaction with the assessments' ability to accurately evaluate student learning (See Table. 4.2). Qualitative insights from surveys, focus groups, and interviews provided further context, revealing three primary challenges: misalignment between assessments and instructional materials, strict time constraints, and technological barriers. Additionally, instructors raised concerns about academic integrity during online exams, which added complexity to the assessment process.

To contextualize these challenges, the NOL MTH 161 course syllabus is outlined here to describe the structure and policies governing assessments. Proctored assessments hold significant weight, accounting for 70% of the final grade, while the remaining components include 5% for the syllabus quiz and discussions, 10% for homework, and 15% for quizzes. Homework and quizzes are completed in ALEKS, while the syllabus quiz, discussions, and exams, including the final, are conducted on Canvas. To pass the course with at least a “D,” students must achieve both an overall average of 60% and an exam average of 60% or higher. If the exam average falls below 60%, the final grade automatically converts to an “F,” regardless of performance in other areas such as homework or discussions.

Multiple proctoring tools are mandated for the course, including the ALEKS Lockdown Browser for quizzes, the Canvas Respondus Lockdown Browser for exams, and the Honorlock Chrome extension. Students must complete an Honorlock tutorial before their first exam.

Throughout the course, students take four exams, each consisting of two parts: Part 1 involves completing questions on paper, while Part 2 requires students to scan their written work and submit it as a single PDF for grading. After the exam, students have 15 minutes to submit the scanned PDF. Penalties apply for late or incomplete submissions: a 10-point deduction for uploads made within 15–30 minutes of the deadline and a zero for submissions beyond 30 minutes. No retakes or extensions are permitted for exams.

These policies describe the procedural and technical requirements associated with proctored assessments in NOL MTH 161, which carry significant weight in determining final grades. While they aim to maintain academic rigor, they also place significant pressure on students, amplifying the challenges identified in survey and qualitative data. This context provides a foundation for examining how these policies and structures shaped both student and instructor experiences with assessments in the course.

One student found the practice quizzes within the course modules to be helpful tools for building confidence, noting, "One specific moment was when I used the practice quizzes in the module. They closely mirrored the types of questions on the actual exams, which gave me confidence going into the exams" (Survey_students, QID10_R3). However, for many other students, this positive experience was overshadowed by frustrations over a perceived disconnect between the instructional materials and the rigor of the exam content.

As one student explained, "The test covered some of the materials we learned in class, but some of the questions were so much harder than the ones we practiced for homework, and I had no idea how to do them" (Survey_students, QID11_R6). Another student echoed this concern, asking, "What parts of these learning concepts, formulas, or questions would be in the exams?" (Survey_students, QID11_R8) These comments highlight gaps in clarity and preparation that left students feeling unprepared and demotivated. An instructor similarly observed, “I think the material is overall more difficult than most of the MTH 161 courses on campus” (Survey_instructors, QID11_R12), offering additional context to the challenges students faced.

Another student highlighted the inconsistency between different assessment types, stating, “The homework and quizzes were not written by the professor and were much more difficult. There were times where I had to skip questions entirely just because they were near impossible for me to answer” (Survey_students, QID11_R5). These perspectives suggest a perceived misalignment between instructional materials, the skills being evaluated, and the level of rigor. This disconnect not only affected students’ confidence but also hindered their ability to effectively demonstrate their learning.

Time constraints emerged as a critical issue, exacerbating stress and limiting students’ ability to demonstrate their understanding. One student remarked, “I needed more time to think through steps, but it felt so rushed” (Survey_students, QID11_R10), while another stated, “Exams were extremely difficult, and I didn’t finish some of the questions or get good grades” (Survey_students, QID11_R9). These comments highlight the challenges students faced when they were trying to balance comprehension with the pressure of time.

Abdul, a focus group participant, elaborated on the overwhelming nature of the exams:

> The exams were overwhelming. I never had enough time to finish all 25 questions, and now I’m stressed about how I’ll even complete the final exam on time. Having to use the camera during exams stresses me out too. (Focus Group, para. 11)

Instructors also acknowledged the impact of time constraints. Professor Rachel reflected:

> Exams are definitely a challenge. Honestly, I think we need a better plan for how exams are structured. One issue I see is with students who start off strong on exams but run out of time halfway through. The time pressure often causes them to panic, which makes it even harder for them to finish. (Interview_1, para. 17)

Another instructor pointed to flaws in the assessment design: "The exams present significant challenges for students. Certain questions are unclear or confusing, and some questions are unreasonable within the time constraints provided" (Survey_instructors, QID49_R4). These observations highlight challenges in designing assessments that account for the varying paces at which students process and apply mathematical concepts.

Technological issues significantly compounded the challenges students faced during assessments and their overall learning experience. A common theme that emerged from student feedback was frustration with the logistics and usability of the required tools. One student criticized the lack of clarity surrounding the use of Lockdown Browser, stating:

> NVCC requires students to download two different versions of Lockdown Browser—one for quizzes and one for exams—but this is never clearly explained anywhere, which is literally insane. The interface for quizzes and exams is a complete disaster, and I've complained about this, but it's still not fixed. (Survey_students, QID11_R2)

The integration of multiple tools, such as ALEKS and Canvas, yielded mixed results. Some students and instructors found the tools beneficial when functioning as intended, while others noted significant barriers. One instructor shared:

> The integration between Canvas and ALEKS is not seamless. Students struggled to track due dates due to the lack of synchronization between Canvas and ALEKS. Students

> appeared confused about the distinction between quizzes and tests. (Survey_instructors, QID49_R1)

Similarly, another instructor highlighted the unique challenges external tools posed for students:

> External web tools like ALEKS creates unique challenges. Students struggle with maintaining self-motivation and adapting to the varied learning paces supported by ALEKS. They frequently encounter technical issues, and the added anxiety from assessments worsens the situation. (Survey_instructors, QID49_R3)

While a few students appreciated the integration of resources, such as one student who described ALEKS and the Miller textbook as “literally amazing” and “exponentially better than anything available” (Survey_students, QID10_R2), many struggled with the technical learning curve. For example, one student explained:

> I learned many concepts. Once I got used to ALEKS, it was a good tool to learn. But it took a couple of weeks at the beginning of the semester to figure out where I could find the things I needed to learn and do homework. (Survey_students, QID10_R9)

The use of multiple platforms for assignments was noted by some students as a source of confusion. Diego, a focus group participant, shared:

> It was frustrating trying to figure out where everything was. Some weeks, assignments were on ALEKS, and others were on Canvas. Plus, I lost access to ALEKS after the free trial ended and had to wait a week to access my homework again. (Focus Group, para. 23)

Moreover, the lack of a cohesive interface for assessments was a recurring concern. One student described the issue as follows: “There is no more important human-computer interface than quizzes and exams, and it's a complete disaster. I suspect it reflects short-term workarounds used to integrate Canvas, ALEKS, LDB, and NVCC's legacy system" (Survey_students, QID11_R2).

These sentiments were echoed by Professor Maria, who noted:

> Some students run into a lot of technical issues early in the semester. It's better now, but we used to have more problems with ALEKS—accessing homework, navigating external tools, and figuring out how to read the online textbook. If they don't get the help they need quickly, it creates a lot of anxiety for them. (Interview_2, para. 8)

While some students struggled, others like Sofia, a focus group participant, effectively utilized ALEKS as a resource for independent learning:

> I could have reached out to my professor, but I mostly relied on ALEKS for examples and homework. The automatic feedback in ALEKS was really helpful—I took notes from it to prepare for exams. I ended up with a lot of notes in my notebook! I think we had plenty of resources to help us succeed. I really liked using ALEKS. (Focus Group, para. 8)

Despite its potential to support independent learning, the inconsistent user experiences and technical barriers highlighted significant areas for improvement in the integration and usability of learning and assessment tools.

While the above findings summarized common themes across data sources, the following insights highlight unique perspectives shared by students and instructors that were not necessarily validated by other sources. Two instructors expressed significant concerns about academic integrity during online exams. Professor Maria remarked: "If students are finding ways to cheat, even on camera, we need to rethink how we're assessing them through exams…This is definitely something we need to address" (Interview_2, para. 16). Similarly, another instructor echoed this concern in response to the survey question, 'How does the overall design of NOL MTH 161 support or hinder student learning? Please provide examples or suggestions for changes or improvements.' They observed: "There are widespread academic integrity concerns, with many students using apps or unauthorized devices to cheat on exam" (Survey_instructors, QID50_R2).

Beyond issues of integrity, the high-stakes nature of assessments in NOL MTH 161 contributed to a pattern of student withdrawals, particularly following the first exam. One instructor noted: "Many students struggle with learning math asynchronously and tend to drop out early, particularly after a failed exam or upon realizing the limited direct instructor support" (Survey_instructors, QID49_R2). Professor Rachel reflected on how the release of first exam grades influenced students' expectations and performance during the Add/Drop period:

> Some of this might be on me. Maybe my grading feels harsh to some students, but I try to grade in detail, especially on the first exam. I think part of the struggle is that students are adjusting their expectations. (Interview_1, para. 21)

Despite these challenges, instructors observed that the first exam often served as a turning point for student improvement. As Professor Rachel explained:

> I have noticed how much students improve from Exam 1 to Exam 2. That first exam seems to help them figure out how to study better and manage their time more effectively. You can clearly see the progress they make. (Interview_1, para. 1)

However, concerns about the transfer of learning to subsequent coursework persisted.

Professor Maria highlighted a specific example of a student struggling with foundational concepts in a subsequent course:

> I just had a student in my NOL MTH 261 class fail an exam on Exponential and Log Functions—topics they're supposed to have mastered in MTH 161. This student told me she passed NOL MTH 161 with a B, but she couldn't solve even basic exponential equations or evaluate logs. It makes me question whether all students passing MTH 161 are leaving with the skills they'll need for their next math class. (Interview_2, para. 15)

Professor Rachel added another layer to this concern, observing that while students may grasp basic concepts, they often struggle with fluency and applying their knowledge under time constraints:

> Sometimes, it's not that they don't understand the material—they may have a developing basic understanding—but they really struggle with fluency and applying what they know to different types of problems. Add in the time pressure, and it becomes even harder for them to think through the steps and solve problems effectively. (Interview_1, para. 18)

Policies surrounding retakes and extensions were noted as limiting some students' opportunities to address early setbacks. Professor Maria explained:

> When students are struggling, it's a constant back-and-forth. They're asking to retake exams, redo assignments, or get extensions. But I have to stick to the late policy—assignments are open for a week, sometimes even two, so I don't allow late submissions." (Interview_2, para. 12)

These policies were intended to establish consistency and fairness in assessment. For example, students who completed only the first half of an exam due to time constraints received a zero for the unanswered portion, which some students and instructors viewed as a challenge in accurately reflecting learning. While exams provided structured opportunities for feedback and growth, their fixed format and associated technical requirements were noted as contributing factors to difficulties some students experienced in achieving success and maintaining motivation.

The next section transitions to social presence and peer collaboration, focusing on how interpersonal connections and collaborative learning influence students' experiences and outcomes.

Finding 3: Mixed perceptions of peer learning and social presence revealed the benefits of resource sharing, but also highlighted limitations in collaborative activities for supporting deeper mathematical understanding.

Finding 3 addresses both Research Question 1 and Research Question 2, as peer collaboration was identified by both students and instructors as a factor that positively influenced students' experiences in the course, despite notable limitations on its direct impact on mathematical learning. This finding explores how peer collaboration and social presence contributed to engagement and emotional support within the course, while offering observations on their role in learning outcomes. The survey explicitly asked about discussion board activities and social presence to collect quantitative data; however, some students and instructors also independently highlighted these aspects in open-ended responses about what supported student learning. Follow-up focus group questions further explored these themes, providing additional insights into how peer collaboration and social presence were perceived in the course.

There were notable discrepancies between instructors' and students' perceptions of engagement and social presence, as revealed in the survey (See Table 4.6, Figure 4.8, and 4.9). While instructors generally viewed these activities more favorably, students were less likely to find them effective. Discussion board activities were noted for fostering a sense of connection and emotional support, though students reported fewer instances of meaningful collaboration, idea exchange, or enhanced mathematical understanding. Instructors, on the other hand, were more likely to view these activities as beneficial for fostering collaboration, exchanging ideas, and improving students' understanding of mathematical concepts, as reflected in survey responses.

Table 4.6

Student Engagement and Social Presence Summary Table

Discussion Board	Students	Instructors
The Introduction Discussion Board helped students feel connected to the course.	53%	83%
Students are comfortable participating in online discussions	42%	83%
Online discussions helped students collaborate and exchange ideas.	32%	67%
Online discussion enhanced students' understanding of mathematical concepts	16%	67%

Figure 4.8

Student Engagement (Instructor Feedback)

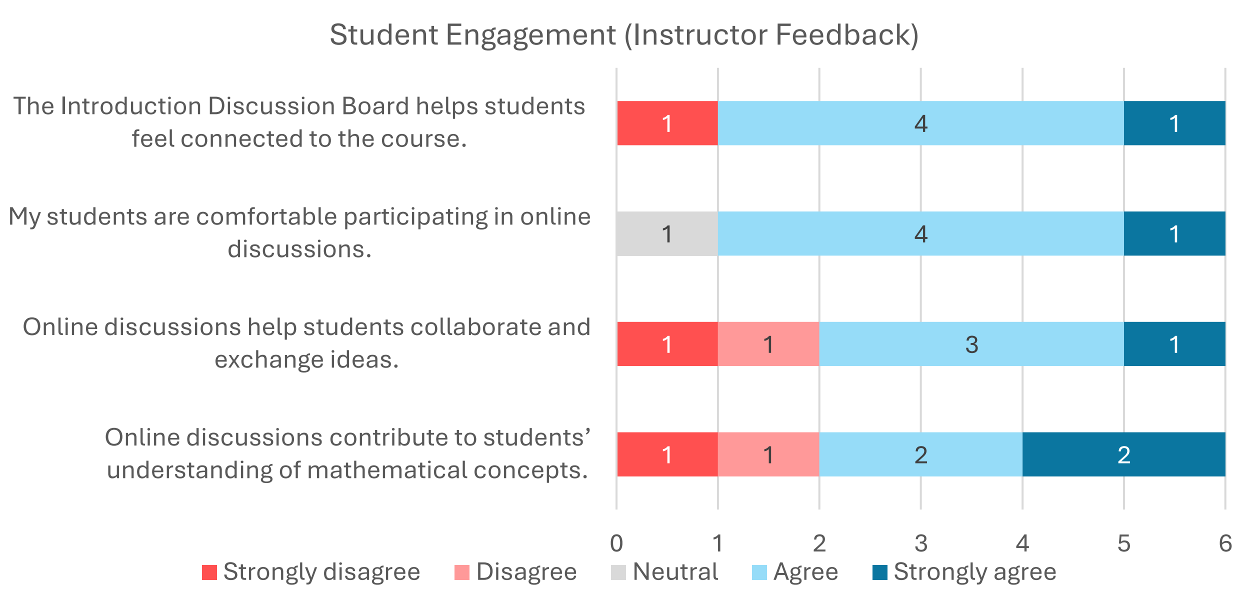
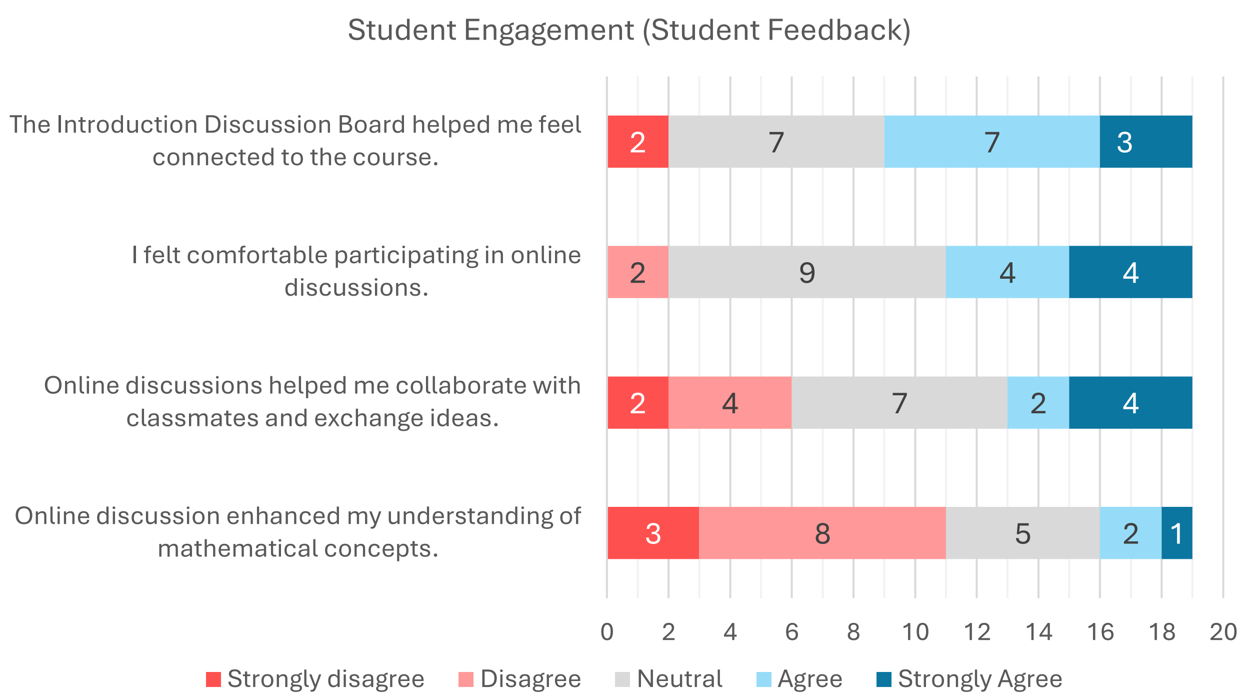


Figure 4.9

Student Engagement (Student Feedback)



Qualitative data highlighted how these activities supported social engagement and connection, while evidence related to mathematical discourse and cognitive understanding was less frequently observed. This finding aligns with prior research on the effectiveness of online discussions, as discussed in Chapter 2. Studies have shown that while online discussions often enhance social presence, engagement, and satisfaction, their impact on actual learning outcomes remains inconclusive (Cho & Tobias, 2019; Lee & Recker, 2022; Jaggars & Xu, 2016), particularly in STEM fields, where activities are often not explicitly designed to encourage higher-order thinking or problem-solving.

A review of the NOL MTH 161 syllabus reveals that discussion boards are a key component of the course design, intended to foster engagement and collaboration among students. The course includes six discussion board activities integrated into the Canvas learning management system: two introductory activities at the start of the course and one in each of the four modules. The first, ‘Welcome: Discussion – Introduction’, invites students to introduce themselves. This is followed by ‘Online Environment’ in Module 1, where students discuss expectations and questions about asynchronous online learning. Module 1 also includes an ‘Exam 1 Review’ discussion, allowing students to post questions, share solutions, and exchange study resources. Similar review discussions are included in subsequent modules for Exam 2, Exam 3, and the final exam. Each activity requires one original post and at least two replies to classmates.

While these discussion boards provided structured opportunities for peer interaction, their effectiveness varied. Both students and instructors highlighted the value of resource sharing and social engagement, yet the activities often failed to foster the meaningful mathematical discourse necessary for deeper cognitive understanding. There is limited evidence supporting the notion that these activities consistently foster advanced phases of cognitive presence, such as refining ideas or applying knowledge to solve problems. To explore these findings further, this section is divided into two subsections: Peer Collaboration and Resource Sharing, and Social Presence and Cognitive Depth.

Peer Collaboration and Resource Sharing

Qualitative insights from survey open-ended responses, focus groups, and instructor interviews provided additional depth on how some students benefited from increased social presence and peer collaboration in NOL MTH 161. Quantitative survey findings showed that 32% of students found online discussions helpful for collaboration and exchanging ideas, and several students further highlighted peer collaboration as a positive aspect of the course in open-ended responses and focus group discussions.

One student shared, “I connected with people taking this course and shared resources to study and pass this class” (Survey_students, QID10_R7). Another highlighted the value of the review discussion activities, stating, “The discussion boards were also great because I could see how other students were solving problems, which gave me new ideas and made me feel less alone in the course” (Survey_students, QID10_R11).

Phrases from these responses, such as “connected with people,” “feeling less alone in the course,” and “felt more comfortable joining in,” support the quantitative findings that the Introduction Discussion Board activity helped 53% of students feel connected to the course and that 42% felt comfortable participating in online discussions. Additionally, mentions of “shared resources,” “new ideas,” and observing how other students were “solving problems” highlight the potential role of discussion activities in fostering cognitive presence. However, these cognitive benefits were only mentioned by a small number of students in the survey.

Aaliyah, a student in her first online math class, described her positive experience with the course’s social presence, even though it differed from her previous in-person classes. She shared, “It was my first online class, and I struggled a bit, but knowing my professor and some classmates really helped… I found the discussion board useful, reading what others shared helped me prepare too” (Focus Group, para. 6). Reflecting on her experience in NOL MTH 161 compared to her earlier in-person MTH 154 course, she added, “I didn’t really connect with anyone in this class like I do on campus. It’s just a different experience” (Focus Group, para. 15).

Aaliyah’s comments reflect engagement with the social presence provided in the course. She actively built strong connections with her instructor and sought to engage with peers, leveraging available opportunities to foster a sense of community and support. Her success strategy was likely supported by her prior experience taking a college-level course with the same instructor—a familiarity uncommon for many gateway math students in NOL MTH 161, who typically take gateway courses during their first semester of college. However, her ability to navigate support systems and make the most of social presence highlights the importance of fostering these skills and opportunities for all students. This suggests that enhancing social presence in NOL MTH 161 may support novice online learners in building connections and engaging in collaborative learning.

Three instructors also highlighted the value of these activities in fostering connections and collaborative learning. One instructor commented, “The quizzes and discussions posting problems helped” (Survey_instructors, QID48_R1), referring to the exam review discussions. Another instructor shared, “This is the first time I've taught for NOL and the semester is only half over, so I can’t be sure. However, I think the review discussions are helpful” (Survey_instructors, QID48_R5). While these responses lack specificity about how the discussions were helpful, a third instructor provided more detail on their role in supporting collaborative exam preparation, stating, “Some students participate in the discussion board activities during review to share resources they found helpful to study collaboratively online and exchange feedback on their exam study questions” (Survey_instructors, QID48_R2).

Professor Rachel, during a semi-structured interview, echoed this sentiment, noting that while participation tapered off as the semester progressed, the discussion boards helped create a sense of connection among students. She explained,

> I’d say less than half of my students really take advantage of the discussion boards now. Participation tends to be higher at the start of the semester, but it drops off as time goes on… Discussion boards help students feel like part of a group and create a sense of connection. (Interview_1, para. 32)

Some students, like Aaliyah, highlighted the relational aspect of the discussions, with repeated participation fostering a sense of familiarity and comfort. She shared, “I feel like it was always the same people commenting. By the third discussion, I recognized some names and felt more comfortable joining in” (Focus Group, para. 26). Her observation of “always the same people commenting” complements the survey finding that 58% of students did not report feeling comfortable engaging in online discussions, suggesting that some students’ lack of comfort may have contributed to limited participation overall.

Another student in the focus group, Sofia, shared that seeing other students’ questions and answers helped her understand the material better. She said, “Discussion boards are fine. Seeing other people ask similar questions and reading the answers helped me understand the material better” (Focus Group, para. 16). However, when responding to a follow-up question about the role of online discussions in helping with mathematical understanding during exam preparation, she noted, “I didn’t rely on online discussions too much. By the time I joined the discussions, I was ready for the exam and just had one or two questions” (Focus Group, para. 25).

This limited engagement coincided with the design of discussion prompts and their timing, which focused primarily on reflecting on questions before exams. It remains unclear whether the discussion prompts were designed to promote critical thinking, problem-solving, or higher-order cognitive skills and if they could better engage students in active discussion and meaningful mathematical discourse. Student responses suggest that the discussion boards were primarily used for posting questions, exchanging resources, and addressing immediate concerns, rather than for extended exploration of mathematical concepts.

Not all students found the discussion boards to be their primary source of collaboration. Diego described an alternative, informal approach to peer support, saying:

> I'm in a Discord group with people from this class, and it honestly made things so much easier… We could share stuff like notes and talk casually about the assignments and exams. It was way more chill and helpful than the discussion boards. (Focus Group, para. 17)

In response, another student Abdul echoed Diego's sentiment and agreed that he relied primarily on other resources for his exam prep. In response to Sofia and Abdul's comments on the use of online discussions to better understand math concepts, Abdul added, "I mostly worked with my tutor, who helped me solve problems and explained things I didn't understand. But the discussion board was still useful to see if others were struggling with the same questions or issues" (Focus Group, para. 28). While these insights highlight the benefits of peer collaboration in fostering social presence and providing opportunities for resource sharing, they also reveal that these activities were often used in a supplementary capacity rather than as a primary tool for deeper learning.

Social Presence and Cognitive Depth

In the conceptual framework, interactions facilitated through discussion board activities and other opportunities designed to promote social presence were identified as critical components of the Social Presence Playground within an asynchronous online math classroom (see Figure 1.1). These interactions were envisioned as catalysts for fostering deeper critical thinking and problem-solving, serving as a bridge to cognitive presence by solidifying learning through meaningful exchanges and interactions. Findings from this study indicated that discussion board activities contributed to group cohesion, a sense of community, and satisfaction with peer interactions. Some students, however, expressed discomfort in sharing ideas, suggesting varying levels of open communication.

The findings did not reveal substantial evidence of peer feedback driving learning outcomes. While the conceptual framework envisioned peer feedback as a mechanism to enhance motivation, build confidence, and foster a positive attitude toward learning, these outcomes were predominantly linked to individual interactions between students and instructors. This overlap between social and teaching presence leaned more heavily toward teaching presence. These findings raise questions about whether social presence created through peer interactions—or more specifically, peer collaboration—functions as a meaningful learning tool in NOL MTH 161.

The survey results highlighted a significant disparity between instructor and student perceptions of the discussion board activities. While 67% of instructors believed these activities were helpful for fostering collaboration and exchanging ideas, only 32% of students agreed. The gap widened further when the survey addressed the discussion board's role in enhancing students' understanding of mathematical concepts. Here, 67% of instructors indicated a positive view, compared to only 16% of students. Moreover, 58% of students strongly disagreed or disagreed with the statement that online discussions enhanced their understanding of mathematical concepts—nearly four times the number of students who agreed or strongly agreed. Although no qualitative evidence directly explained these survey findings, the lack of evidence may underscore the limitations of discussion board activities in fostering deeper cognitive engagement in NOL MTH 161.

Professor Rachel's observation about the discussion boards adds some context to these findings. She noted, "Most of the [discussion board] posts don't go very deep. It's more about sharing links or resources than really talking through math problems or concepts" (Interview_1, para. 33). This limited engagement may provide context for why some students, like Diego, sought alternative methods for learning and understanding mathematical concepts. In the focus group, Diego shared, "I prefer someone walking me through each step" adding that he relied on tools like "ChatGPT and Photomath for studying" (Focus Group, para. 27). He viewed the discussion board primarily as a means to earn completion grades, stating, "Typing math and symbols is hard. It wasn't something I used much to learn math in this class" (Focus Group, para. 28).

Diego's preference for individualized, guided support highlights a key challenge in fostering meaningful peer feedback in an asynchronous setting. Engaging in meaningful mathematical feedback may require students to have a foundational understanding of the subject. This aligns with the placement of discussion board activities in NOL MTH 161, positioned toward the end of each learning module to encourage students to share and extend their learning. However, whether the limited engagement stems from the design of the discussion prompts, the assignment structure, the written modality of the activities, or other factors remains unclear. These aspects may have influenced the challenges students encountered when participating in mathematical discussions, including those intended to foster exploration, refinement of ideas, and conceptual understanding.

Abdul, another focus group participant, provided further insight into this challenge. While he primarily worked with a tutor to solve problems and address misunderstandings, he acknowledged a secondary benefit of the discussion boards, noting, "The discussion board was still useful to see if others were struggling with the same questions or issues" (Focus Group, para. 27). Both students' experiences indicate that discussion boards may not consistently support advanced mathematical problem-solving and feedback exchange, in part due to structural challenges like typing math symbols and the absence of dynamic, step-by-step interaction. These findings suggest that fostering deeper engagement in online discussions may require strategies tailored specifically to the unique demands of mathematical communication in an asynchronous environment.

It may also be that students were communicating on a platform that felt less comfortable for openly discussing their struggles. Feedback from three focus group participants supports this notion. Diego, for example, shared his preference for an alternative, informal communication channel on Discord, where he felt much more comfortable to "share stuff like notes and talk casually about the assignments and exams" (Focus Group, para. 17) with his classmates without the added pressure of instructor oversight or grading. This informal setting may offer insights into why some students chose not to fully utilize the discussion boards provided by the course. However, whether students actively engaged in meaningful "mathematical conversation" on these informal platforms remains unknown.

The next section explores how instructor presence mitigated some of the challenges of learning mathematics asynchronously for students in this gateway course.

Finding 4: Instructor presence, characterized by accessibility, responsiveness, and proactive engagement, positively influenced student experiences and outcomes, though gaps in personalization and effective utilization of feedback limited its overall impact.

Garrison's Community of Inquiry (CoI) model groups the design, structure, and guidance that shape the learning experience under the broader construct of Teaching Presence. In NOL MTH 161, students and instructors are provided with identical course materials, assessments, and activities. However, how instructors facilitate these elements introduces a critical variable—

instructor presence. Without active instructor involvement, the course relies solely on standardized materials and activities, which some students and instructors perceive as less effective in fostering engagement and learning. Instructor presence, when demonstrated effectively, was associated with more positive student experiences, as reported by some students and instructors. The first component of Teaching Presence—course presence, which includes the materials, assessments, and activities—was addressed in the previous finding. This finding shifts the focus to instructor presence, newly defined as the distinctive ways instructors actively engage with and guide students throughout the course.

This finding aligns with both Research Questions 1 and 2, as instructor presence—or its lack—emerged as a critical factor in supporting or hindering student learning in NOL MTH 161. Three key themes were identified within instructor presence: Instructor Support, Feedback, and Adaptability and Personalization. The presence—or absence—of these elements appeared to influence students' learning experiences and outcomes, as reflected in the data.

Students highlighted several challenges they associated with limited instructor presence, including the lack of real-time support, limited personalization, feedback that did not meet their needs, reliance on external resources, and fewer informal interactions with instructors. Instructors echoed some of these concerns, particularly the lack of real-time support and limited personalization, which they attributed to the rigid course structure. Additionally, instructors identified unique challenges, such as emotional and practical barriers and difficulties in feedback utilization.

To address these challenges, some instructors focused on being available and responsive to their students while providing personalized guidance and supplemental resources. These efforts closely aligned with what students identified as effective and supportive. Students reported that instructor accessibility, proactive communication, encouragement, and structured review sessions were pivotal in overcoming barriers and fostering success.

This section examines both the strengths and gaps in instructor presence. Sub-finding 4.1 explores how instructor availability, responsiveness, and proactive communication supported student engagement and success. Sub-finding 4.2 discusses how gaps in personalization and limitations in feedback utilization presented challenges to deeper learning.

Instructor Support

In the open-ended section of the student survey, participants were asked to describe specific aspects of the course that contributed to a successful experience, along with any examples of positive moments. Many students highlighted their "professor," "instructor," or "teacher" as a central influence on their learning. One student shared, "The instructors I've interacted with at NVCC have generally been very kind and supportive and helpful" (Survey_students, QID10_R2). While this reflection may broadly apply to NVCC instructors and not exclusively to NOL MTH 161, it encapsulates the qualities of instructor support described by other students in this course. To better understand this general "helpfulness" and "support," three subthemes were identified within the broader theme of Instructor Support: proactive communication, responsiveness, and availability. This subsection explores these subthemes and their relationship to student experiences in NOL MTH 161.

A set of rating items on instructor facilitation in both student and instructor surveys explored how frequently instructors engaged in activities to enhance teaching presence in NOL MTH 161. While the course structure limited personalization, instructors were encouraged to use tools like Canvas announcements and messages to proactively communicate with students. Two survey items specifically addressed proactive communication: posting weekly announcements to help students manage time and workload and sending reminders about upcoming deadlines.

The survey results highlighted a generally strong effort by instructors in proactive communication. All instructors (100%) reported often or always posting weekly announcements to help students stay on track, while 79% of students agreed their instructors did the same. However, 11% of students noted their instructors rarely or never posted weekly announcements. While this study had IRB approval from both UVA and NVCC, access to NVCC's Canvas system as an administrator or guest to review course announcements was not available to verify whether announcements were made regularly. A review of instructor activity logs in Canvas could provide clarity; however, such an investigation would require appropriate administrative permissions and might also necessitate more stringent approval from NVCC's IRB Office, as it involves identifiable data and student educational records.

This discrepancy raises questions about whether announcements were consistently made or if students were unaware of them due to notification settings in Canvas. Some students may not have had their email or Canvas notifications enabled, contributing to the perception that announcements were not being posted. Regardless of the cause, this perception impacts students' experiences by potentially reducing their sense of connection, organization, and support in the course. Announcements play a crucial role in asynchronous courses, serving as a bridge between students and instructors by reinforcing course expectations, providing updates, and fostering engagement.

For reminder emails about upcoming deadlines, 83% of instructors and 84% of students reported sometimes, often, or always engaging in this practice, with only 16% of students indicating their instructors rarely or never sent reminders (see Figure 4.8). The "sometimes" response was included to reflect instances where instructors may not have sent reminders consistently like they would've for weekly announcements but still provided enough communication to support students with critical deadlines, particularly for the four major exams students had during the 15-week period.

Qualitative findings indicate that students appreciated proactive communication from instructors. One student commented in the survey: "…I work full-time, so it's hard to submit everything on time, but the reminders and announcements kept me on track" (Survey_students, QID10_R10). Aaliyah, a participant in the student focus group, further emphasized the importance of proactive instructor communication: "My professor is honestly the only reason I passed this class. She was so helpful, always sending reminders and checking in on me if I missed something" (Focus Group, para. 15). Aaliyah's experience suggests that proactive communication, such as reminders and personalized follow-ups, was perceived as supportive in helping students stay on track in an asynchronous learning environment.

The responsiveness and availability of instructors emerged as a key factor supporting student learning. While much of the teaching and cognitive presence is provided by course design, some instructors supplemented instruction by sharing additional resources and offering extra support. All instructors (100%) reported that they sometimes, often, or always created and shared supplemental instructional materials to enhance student understanding, and 79% of students agreed that these materials were provided.

Instructors are required to hold student engagement hours (office hours) to support students weekly, which can include virtual office hours or student support hours for NOL classes. Although 83% of instructors indicated they often or always offered office hours for additional support, only 47% of students reported that their professors provided this resource.

Concerningly, 26% of students said their professors rarely or never offered such support. It remains unclear whether these hours are underutilized by students or if miscommunication has led to their limited awareness or usage. Additionally, only 50% of instructors sometimes or often organized extra review sessions to reinforce learning, with 42% of students agreeing that these sessions occurred. This suggests such events are infrequent, as 50% of instructors and 57% of students indicated that these review sessions were rarely or never provided.

Two comments from the survey emphasized instructor availability and responsiveness as key factors supporting student learning. One student shared, “Professor was always nearly immediately available” (Survey_students, QID10_R5), while another noted, “The instructor has been very kind and supportive” (Survey_students, QID11_R2). A third student remarked, “My professor was always easy to get ahold of through email, answered basic questions I had about the course, and even addressed specific questions I had on individual homework problems” (Survey_students, QID10_R6).

In focus group discussions, students also expressed appreciation for their instructors’ support. Aaliyah, who particularly valued working closely with her professor, explained:

> I emailed my professor and scheduled appointments to meet with her before exams. When I had her for an on-campus class, she held review days, but this online course didn’t have that option. Going to her office hours really helped me.” (Focus Group, para. 5).

However, she added, “I wish we had regular review sessions before exams… Seeing practice problems and similar exam questions really helped me prepare” (Focus Group, para. 24). She also mentioned challenges with external support: “There were weeks when I couldn’t meet with my professor, and when I tried the tutoring center, it wasn’t very helpful.” (Focus Group, para. 10). Her experience highlighted the gap in external resources and students' desire for more structured instructor support.

Student experiences with instructors varied widely, with some students describing these interactions as influential to their overall success in the course. One anonymous student shared a particularly negative experience:

> In the beginning, I asked my professor what his office hours were and if he would be available to meet. His response was that I should transfer to an in-person classroom. I completely understand that I chose an online class, but I was expecting to have some support from the professor, as I have had in the past with other online courses. Next time, I will be sure to do in person since I was unable to get help from my professor outside of email. (Survey_students, QID11_R6)

This student ultimately withdrew from the course due to their frustration with the lack of instructor support. In contrast, Diego, a student from the focus group, shared a positive experience:

> Math isn't really my strength, and it's not my favorite subject either, but I took this course because my professor had good reviews on Rate My Professor. Even though I struggled at times, I still managed to pass and feel ready for the next class. I had a much better experience here compared to another online class I had to drop. People often warn against taking NVCC Online classes, but my experience with this one was positive. I'd take another class if this professor teaches it. (Focus Group, para. 7)

Diego's account reflects his perception that a supportive and approachable instructor contributed to his confidence and satisfaction in the course.

Qualitative insights from instructors further highlighted the strategies they employed to support student learning. One instructor stated, “Offering supplemental resources for particularly challenging lessons supported student success” (Survey_instructors, QID48_R3). Another instructor emphasized the importance of real-time support, sharing, “Students could benefit greatly from synchronous support options, such as live sessions with instructors or tutors” (Survey_instructors, QID50_R2). Similarly, another instructor noted, “Increasing interaction through live sessions, group projects, and discussion forums could foster a sense of community and provide real-time support” (Survey_instructors, QID50_R3).

Professor Maria shared her perspective on the challenges of providing timely support in an asynchronous environment:

> I always try to respond to questions within 48 hours, but even that can feel too slow for some students when they’re stuck. I’ve noticed students falling behind because they couldn’t access their work or get the help they needed in time. Once that happens, the gaps just keep growing. (Interview_2, para. 5).

Although instructors reported providing supplemental resources, fostering interaction, and offering support, students described challenges associated with asynchronous online learning environments. The next subsection explores these struggles, focusing on students’ experiences with a lack of personalization, instructors’ challenges stemming from a perceived lack of autonomy, and the shared struggle of both groups: feedback.

Personalization and Feedback

Student survey results indicate that less than half (47%) of students were satisfied with the course content, while a slightly higher proportion (58%) expressed satisfaction with the support provided by their instructors, including feedback, availability, and additional resources (see Figures 4.9 and 4.10). Notably, 32% of students reported being strongly dissatisfied or dissatisfied with the course content, compared to only 16% who expressed similar dissatisfaction with instructor support. Revisiting the descriptive statistics from the course content and design section, 42% of students strongly disagreed or disagreed that the instructional materials helped them understand mathematical concepts (see Figure 4.3). These challenges may have led students to rely more heavily on their instructors for support. Similarly, with 53% of students strongly disagreeing or disagreeing that the quizzes and exams matched what they learned in the course, the question arises: where do they turn for support? This is where instructor presence becomes critical in mediating these challenges.

Survey responses indicate a potential distinction in how students perceived course content and instructor support. Instructor survey responses corroborate this perspective, as instructors also recognized these issues and took steps to mitigate them. For example, 83% of instructors reported that quizzes and exams did not accurately assess what students were learning, and 50% saw room for improvement in instructional materials to help students better understand mathematical concepts (see Figure 4.4). This distinction suggests that students may perceive course content and instructor support as separate aspects of their learning experience. It also underscores the potential for instructors to address course design challenges through their support, while presenting opportunities to better align both elements—particularly through improved personalization and feedback.

Some students expressed satisfaction with the instructional materials and resources provided in the course. For instance, one student praised the external tool ALEKS, which includes access to the textbook, homework, quizzes, and automated feedback:

“I liked how the homework gave explanations if you got something wrong and the examples it provided while showing what to do. The textbook was also really helpful" (Survey_students, QID10_R4).

Canvas modules also included links to video tutorials NVCC Online provided, which some students found beneficial. One student shared, "The video tutorials were helpful, especially for topics like polynomial functions. During the quadratic equation's unit, I watched videos a couple of times, and it helped me understand how to use the quadratic formula" (Survey_students, QID10_R11). Another student appreciated the overall design of the available resources but acknowledged the ongoing challenges of learning: "The instructors have been very kind and supportive, and I've literally been blown away by how well-designed Miller's textbook and ALEKS online version are. Even with all the support, it's still a struggle to learn" (Survey_students, QID10_R2).

While some students found the provided course materials sufficient for learning, others expressed challenges with their effectiveness. One student commented, "The textbook was quite hard to understand at times. Perhaps this could be fixed by making some concepts simpler with clearer explanations" (Survey_students, QID11_R12). Another highlighted difficulties preparing for exams and achieving good results: "I didn't get a heads up to use the textbook but rather focus more on ALEKS to get past those concepts. So, I didn't do well, lower than 65% on my first exam" (Survey_students, QID11_R8).

While comments above reflect general dissatisfaction with course materials, other feedback provided a more detailed picture of students' struggles, focusing on the lack of personalization and adaptability in the instructional resources. Three comments from the student survey emphasized the need for more personalized instructional materials and resources created by the instructor. One student shared, "The homework and quizzes were not written by the professor and were much more difficult. There were times where I had to skip questions entirely just because they were near impossible for me to answer" (Survey_students, QID11_R5). This feedback highlights not only the difficulty of the assignments but also the disconnect caused by the lack of instructor-created assessments, which the student believed contributed to the increased difficulty. Another student expressed a more detailed concern in their survey response:

> I wished that along with the modules that listed the concepts in order, the professors themselves had a video discussing the concepts so I'd feel more connected to how I should do it in this class. I'd feel more connected to how I should do it in this class than feel uncertain on which ways I should go about a problem when I seek other sources to help me understand that explain it or solve it differently. (Survey_students, QID11_R8)

The feedback suggests that some students value instructor-created videos as a complement to course modules. The student articulated feeling disconnected and uncertain when relying on external sources that often presented different methods or explanations for solving problems.

As reviewed earlier in Chapter 2, studies have shown that multimedia instructional materials, such as instructor-generated videos in addition to text-based content, can significantly enhance student learning and satisfaction. For example, Choe et al. (2019) found that participants rated videos with a strong instructor presence (e.g., the instructor appearing on screen) as more engaging and satisfying compared to videos with less instructor presence, which were perceived as boring and unengaging.

Another student, who had earlier praised their instructor's availability for homework support, shared a contrasting experience by criticizing the lack of instructor-generated resources:

> However, all his resource material was from YouTube. There were no videos of him teaching the material based on what's on his homework and test, and I think this is where the problem is and why most people are failing this course when it's given online. (Survey_students, QID10_R6)

Students noted that while external resources such as YouTube can be supplemental, alignment with course assessments may vary. Since the same mathematical concept can be assessed in multiple ways, students relying on external instructional videos may struggle when the methods or applications differ from what and how is tested in the course. This highlights a recurring theme in student feedback: the perceived need for better alignment between instructional materials and assessments, as well as resources tailored to the course.

Instructors have taken varied approaches to address these challenges, and many recognize and agree with the struggles their students have expressed. They acknowledge difficulties related to support and assessments, as one instructor noted, "The absence of immediate support compounds the challenges students experience with ALEKS. Students experience heightened anxiety due to assessments" (Survey_instructors, QID49_R3). Another instructor highlighted the impact of rigid course policies: "The strict no-late-work policy and automatic zeros for late homework discouraged many students, particularly those who fell behind early on" (Survey_instructors, QID49_R2). One instructor emphasized how the course structure limits their ability to effectively support students, sharing their frustration in the survey: "The main problem with this course is the lack of autonomy for instructors; I can't change anything when I know my students are struggling" (Survey_instructors, QID50_R5). Instructor feedback highlights awareness of the challenges students face, as well as opportunities for structural changes to course design and support systems.

Professor Rachel, during her one-on-one interview, elaborated on the limitations she faced in personalizing and differentiating the learning experience to better meet her students' needs. Reflecting on her inability to improve the course design, she explained:

> As instructors, we have no control over the lesson structure and are tied to the fixed pacing of the course. This is very different from my in-person sections of MTH 161, where I have the flexibility to decide which topics to focus on more or skip entirely. That flexibility lets me prioritize what students truly need to succeed in calculus. (Interview_1, para. 30).

While the lack of personalization in the course design is a clear challenge, instructors are finding ways to tailor the learning experience and address individual student needs through feedback.

Instructor Feedback

Instructor feedback emerged as an area with potential for further exploration and improvement. Both students and instructors have identified significant gaps in the consistency, quality, and effective utilization of feedback in NOL MTH 161. Surveys asked both instructors and students about the timeliness of feedback on assignments. The student survey had one additional question asking for the impact of instructor feedback on their learning. On the rating item assessing how frequently instructors provide detailed feedback on assignments within one week to help students improve their understanding, 83% of instructors indicated often or always and no instructor said rarely or never. On the same rating item, asking if their professors provided timely feedback on assignments, slightly lower 63% of students agreed. About one-third (32%) of students reported that they sometimes received timely feedback, only 5% said they rarely received it, and no student reported never receiving timely feedback.

In an additional rating item measuring the effectiveness of instructor feedback, students were asked how frequently feedback on assignments helped improve their understanding. While 37% of students reported that feedback was often or always helpful, an equal proportion (37%) found it sometimes helpful, and over a quarter (25%) said it was rarely or never helpful.

Two students and one instructor provided qualitative insights on feedback. One student described the lack of feedback on exams, stating, “I was not able to go back and find out how I did other than just my grade” (Survey_students, QID11_R10). In contrast, Ethan shared a positive experience during the focus group discussion, reflecting on how feedback from his professor gave him confidence for future exams:

> I thought I had completely failed my first exam, but when I saw my grade and read my professor's comments in a separate document, I was so relieved that I passed. It wasn’t the grade I wanted, but it gave me confidence, and I realized I needed to show more steps to get full credit on future exams. (Focus Group, para. 3)

Ethan’s experience illustrates how personalized feedback can provide guidance and support for future improvement. Professor Rachel, in her one-on-one interview, elaborated on her approach to providing detailed, personalized feedback, particularly after the first module exam. She described how many students, disappointed with their grades, sought her guidance on their performance and future options:

> After Exam 1, I spend a lot of time meeting with students or exchanging emails. A lot of them are pretty disappointed with their grades, whether it’s a failing grade or even a B for those aiming higher… Students usually come in asking about retakes or if they still have a chance to pull off a C or B. That’s when I pull out the syllabus and walk them through their options. I try to keep it as constructive as I can, so they don’t feel defeated… Some

> students feel like it's unfair [that they are not allowed to retake exams and or how their work is graded], but I try to encourage them. I'll show them examples of what we're looking for so they can get it right next time. These conversations can get emotional, but I always try to make sure they leave feeling positive about moving forward. (Interview_1, para. 2, 7, 11)

Professor Rachel's feedback practices included elements of advising and guidance for novice college students. This evidence illustrates how one instructor expanded her role to meet the varied needs of her students in the NOL MTH 161 course. In contrast, another instructor expressed frustration with these additional demands, stating in the survey, "Some students require additional support, such as a social worker, which is beyond the role of the instructor" (Survey_instructors, QID50_R1). While not acting as a social worker, Professor Rachel stepped beyond her traditional role, taking on the responsibilities of an advisor and guide.

This approach suggests the broader role instructors may play in supporting student motivation and engagement. Beyond providing academic feedback, Professor Rachel's efforts to support her students emotionally and practically reveal the multifaceted nature of effective teaching in this context. She further elaborated on her grading and feedback practices, explaining:

> Exam 1 grading and feedback is definitely the busiest time for me in NOL 161. I spend a lot of time writing detailed feedback and holding office hour meetings with students… I spend a lot of time talking about showing all their work on exams. They'll ask where they lost points, even when their answers are right. I have to explain that we're grading more on the process, not just the final answer. (Interview_1, para. 4, 9)

Her feedback emphasized problem-solving processes, which align with foundational skills necessary for success in higher-level math courses. However, she concluded the interview on a more concerning note, expressing doubt about whether her efforts were achieving the desired impact:

> Feedback plays such an important role… We don't get an answer key for grading these exams, so I have to spend time reviewing all the work students show in Part 2…. providing detailed feedback in this course, but I'm not convinced it's having the impact I'd like on student success" (Interview_1, para. 12, 19, 31).

This case provides an example of how personalized feedback was used to offer both academic and emotional support. While the qualitative evidence on the effectiveness of instructor feedback is limited in this study, Professor Rachel's approach highlights the potential of detailed, personalized feedback to bridge gaps in understanding and foster student confidence. However, her reflections also reveal an underlying concern about whether feedback is being effectively utilized by students, pointing to a broader challenge within the course. These reflections suggest a need to explore more structured feedback strategies that address both immediate challenges and support long-term learning.

Discussion

The data and findings presented in this chapter address a critical problem of practice at Northern Valley Community College (NVCC): the persistently low success rates (20%-41%) in asynchronous online sections of the STEM gateway math course, MTH 161 Precalculus I (NOL MTH 161). These low rates directly hinder NVCC's strategic goal of improving retention through timely completion of gateway courses. As enrollment in asynchronous formats continues to grow, understanding the factors that influence student learning in these courses is essential for effectively supporting NVCC's student population.

This study aimed to identify the factors that instructors and students perceive as either supporting or hindering learning in NOL MTH 161. Previous research on gateway courses has primarily focused on the effectiveness of corequisite remedial education and accelerated models to increase early momentum, where targeted support mechanisms, such as embedded tutoring and just-in-time interventions, are integral to course design. However, there is limited research on the experiences of community college students in asynchronous, gateway-level math courses who lack such structured supports. Additionally, studies on gateway math at community colleges tend to emphasize synchronous or in-person learning environments, overlooking the unique challenges and opportunities of asynchronous formats. By addressing these gaps, this study provides new insights into how asynchronous gateway courses can better support student success in community colleges.

Preparedness and Student Success in Asynchronous Learning

Finding 1 highlights how varying levels of mathematical preparedness and readiness for college-level coursework shaped students' initial experiences in NOL MTH 161. These factors, explicitly identified by instructors and reflected in student survey responses and focus group discussions, were significant early influences on learning. Preparedness impacted students' ability to adapt to the demands of the course and persist in an asynchronous, self-directed learning environment, with some students ultimately facing withdrawal. The literature consistently emphasizes that underprepared students are at a higher risk of failing, dropping out, or changing majors (Chen, 2016; Shudde & Akiva, 2019). This study aligns with these findings while highlighting a new dynamic: students in asynchronous sections were often advised by their instructors to transfer to synchronous sections of MTH 161, where real-time support and developmental coursework were more readily available.

One instructor remarked, “NOL MTH 161 works really well for the students it’s designed for—those who thrive in an independent, online learning environment” (Interview_1, para. 1). While this highlights the course’s potential for self-directed learners, it also raises questions about how well it supports students who struggle with independent learning. Challenges such as math anxiety and limited prior experience with online coursework can impact student confidence and performance. Advising struggling students to transfer to in-person sections may seem like a straightforward solution; however, if these students meet the same prerequisites as their peers, this approach may not fully address the challenges they encounter in the asynchronous format. Instead, identifying ways to enhance support within the existing structure can help more students succeed.

The role of relational continuity emerged as another mitigating factor, with students who were familiar with an instructor from a prior course reporting an easier transition to college-level coursework. Stronger connections with instructors and effective use of support services helped students overcome challenges. However, underutilization of resources like student engagement hours points to a disconnect between availability and usage. Encouraging students to engage with these resources remains critical, as supported by broader research on teaching presence and resource engagement in online courses (Hegeman, 2015; Kumar et al., 2019).

The increasing reliance on AI-powered calculators and other external tools like Mathway and PhotoMath presents another area for exploration. These tools may support problem-solving, but their role in fostering conceptual understanding remains unclear. Research could investigate how these technologies, when integrated into the curriculum, complement guided learning strategies and enhance student engagement. This finding highlights the need for course structures that support varying levels of preparedness, as prior research has shown that readiness and access to appropriate resources are critical for student success in gateway math courses (Chen, 2016; Bailey et al., 2010).

As a required gateway course, NOL MTH 161 plays a pivotal role in students' academic trajectories. Its dual potential—to act as a pathway to upward mobility or a barrier for underprepared students—depends on how well course design, instructional strategies, and support systems address disparities in preparedness and access. Addressing these elements is essential for reducing barriers and fostering success in online, asynchronous math education.

Standardized Design and Assessment: Benefits, Challenges

Finding 2 highlights both the positive and negative impact of the course's standardized structure and assessments in NOL MTH 161. While the structured design provided consistency and supported navigation, it limited adaptability for both students and instructors. Additionally, assessments posed significant challenges due to misalignment with instructional materials, rigid policies, and time constraints, which disproportionately hindered student learning and performance. These findings reveal important implications for theoretical understanding and practical application.

The course's nonmathematical demands—such as navigating multiple platforms, meeting strict proctoring requirements, and adhering to inflexible time constraints—introduced extraneous cognitive load that detracted from students' ability to engage deeply with mathematical concepts. These additional barriers shifted focus away from learning to managing logistical challenges. Moreover, these nonmathematical demands created additional hurdles for students unfamiliar with the course's structure, requiring proficiency in technology, time management, and self-directed learning. Addressing these unspoken expectations is critical for ensuring that students have meaningful learning opportunities in asynchronous gateway courses.

Structured modules and consistent expectations supported cognitive presence by offering clarity and organization, which were particularly beneficial for novice online learners. However, the rigidity of the course structure limited instructors' ability to personalize learning or adapt instruction for students struggling with complex topics. This tension suggests that balancing standardized course design with instructor flexibility could better support student learning. Future research might explore how increased instructor input during course development could improve alignment between design, instruction, and student outcomes.

Assessment design presents challenges for student success. Time-limited exams, automatic penalties for late submissions, and strict deadlines created barriers for students who needed additional time or faced technical issues, limiting their ability to demonstrate their learning. These findings also question whether current assessments adequately prepare students for applied calculus. Shifting from a focus on pass rates to evaluating readiness for advanced applications could better align assessments with long-term educational goals.

Concerns about academic integrity during online exams further complicate the implications of assessment design. While proctoring tools aim to uphold rigor, instructors expressed frustration over their limited ability to fully prevent unauthorized resource use. These challenges underscore the need to critically reexamine the role and design of assessments in asynchronous courses. Future research could explore alternative assessment strategies—such as applied tasks, open-resource formats, or project-based evaluations—to determine their effectiveness in accurately measuring student learning outcomes. Such investigations might also address the limitations of traditional proctored exams while maintaining academic standards and preparing students for future coursework.

Peer Learning and Social Presence: Challenges and Opportunities

Finding 3 highlights mixed perceptions of peer learning and social presence in NOL MTH 161. While students and instructors recognized the value of resource sharing and emotional support fostered through social presence, there is limited evidence that collaborative activities led to meaningful mathematical discourse or deeper learning. Instructors largely perceived discussion board as an effective tool for fostering collaboration, exchanging ideas, and enhancing students' understanding of mathematical concepts. However, students expressed a more limited appreciation, with less than half feeling comfortable participating in online discussions, and even fewer finding these activities helpful for collaboration, exchanging ideas, or enhancing their understanding of mathematical concepts. Most students, in fact, did not believe online discussions significantly contributed to their understanding of mathematical concepts. This aligns with prior research (e.g., Garrison et al., 2000; Martin et al., 2022), which suggests that while social presence enhances engagement and satisfaction, its direct impact on learning outcomes is often limited. The disconnect between the course's assignment design and students' engagement highlights the need to reexamine how collaborative opportunities are structured and communicated in asynchronous courses.

Garrison et al. (2000) emphasized that social presence must integrate with cognitive and teaching presence to achieve meaningful learning outcomes. Lee and Recker (2022) demonstrated that high-quality discussion posts—those involving evaluation, synthesis, or application of knowledge—positively correlated with students' final grades. However, it remains unclear whether students who participated in these discussions already had strong foundational knowledge, as Sofia's example of being prepared for her exam before engaging in the review discussion suggests. This raises questions about whether such discussions inherently foster deeper learning or primarily benefit students who are already well-prepared.

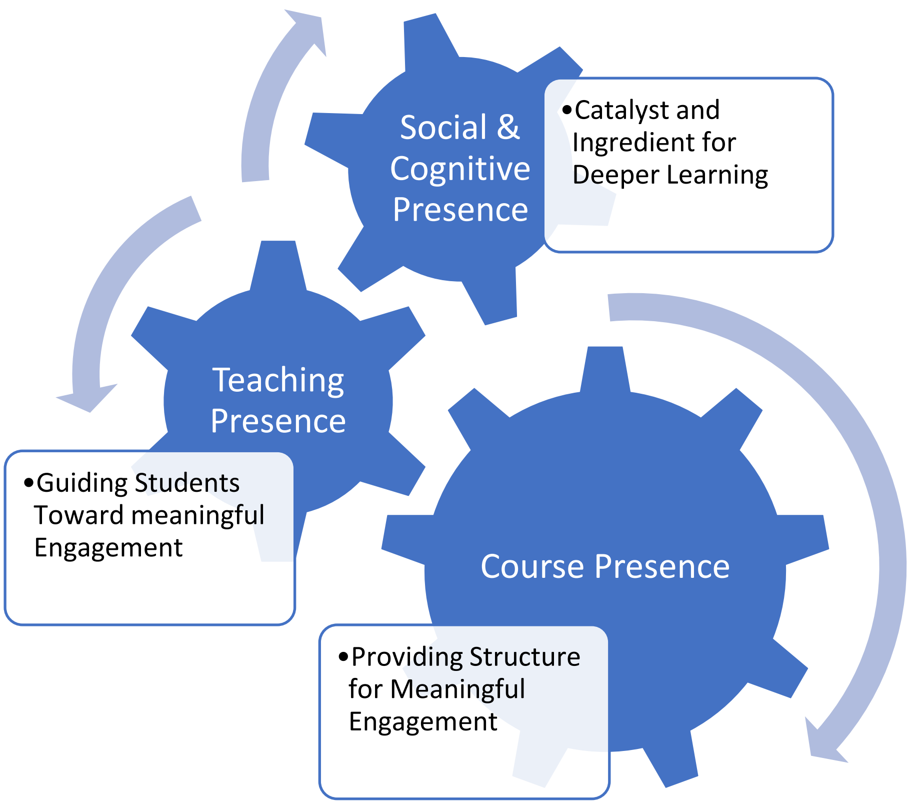
For theoretical implications, future research should examine the influential role of teaching presence (both instructor and course presence) in enhancing the interplay between social and cognitive presence. Although there was no direct evidence of instructors actively guiding discussions in this study, NOL instructors are encouraged to facilitate meaningful exchanges. The presence—or absence—of instructor involvement could significantly influence the depth and quality of peer discussions. Refining the Social Presence Playground within the conceptual framework by incorporating well-designed discussion prompts and instructor facilitation could help promote deeper mathematical thinking and meaningful exchanges, particularly for novice learners in asynchronous gateway math courses.

From a practical perspective, this finding emphasizes the importance of discussion prompt design and assignment structure in shaping the depth of student interactions. Prompts that explicitly encourage critical thinking and problem-solving could elevate discussion boards from surface-level exchanges to tools for meaningful cognitive engagement. Additionally, addressing challenges students face in articulating mathematical reasoning—such as difficulties typing math symbols or explaining problem-solving processes—could improve participation and outcomes. Providing support or technological tools to ease these challenges should be a priority.

The informal use of external platforms for peer collaboration highlights a need to better understand and potentially integrate unstructured learning environments into formal course design. If discussion boards are not students' preferred method for engagement, alternative approaches—such as flexible communication tools or peer-led study groups—could supplement or replace traditional discussion boards. Incorporating elements from informal networks may foster greater engagement, promote collaborative problem-solving, and enhance the overall learning experience in asynchronous online math courses.

Figure 4.10

Interconnected Dimensions of Presence in Online Learning



Instructor Presence: Bridging Standardization and Student Support

Finding 4 highlights the significant impact of instructor presence—characterized by accessibility, responsiveness, and proactive engagement—on students' experiences and outcomes in NOL MTH 161. While instructors played a crucial role in fostering engagement and providing support, gaps in personalized feedback and real-time interaction limited their overall effectiveness. These findings suggest that instructor presence was pivotal in bridging the standardized course structure and individual student needs in NOL MTH 161.

The findings from this study suggest that the traditional Community of Inquiry (CoI) model may not fully account for the complexities of asynchronous online courses like NOL MTH 161. While teaching presence in the CoI framework includes both course presence (design, structure, and materials) and instructor presence (engagement and interaction), the findings indicate that instructor presence plays a uniquely critical role. Specifically, it acts as a mediator between students and the standardized NOL MTH 161 course structure, shaping learning outcomes in distinct ways. Rather than a single unified presence, course and instructor presence function as two separate but interdependent elements that must work cohesively—one complementing rather than hindering the other. To better reflect these dynamics, a refined framework that more clearly distinguishes between course presence and instructor presence could provide a deeper understanding of their respective contributions in asynchronous environments.

The findings also emphasize the expanded role of gateway instructors, who are often expected to act as advisors and mentors in addition to teaching content. This is particularly relevant for at-risk students, who often face additional academic and personal challenges that require individualized support. Research suggests that instructors in gateway courses frequently take on roles beyond traditional teaching, providing mentorship and guidance to help students navigate academic expectations and access institutional resources (Hogan et al., 2016; Martin et al., 2021). These supportive roles not only foster a sense of belonging but also play a critical role in shaping first-year students' academic trajectories, particularly through targeted support mechanisms for underprepared learners.

Additionally, feedback emerged as a potentially significant learning mechanism, though inconsistencies in its use and impact highlight the need for further research. Exploring how students engage with feedback and identifying strategies for its effective utilization could unlock its potential to drive meaningful learning outcomes.

A key practical implication is the need to increase instructor autonomy within standardized course structures. Allowing instructors greater flexibility to adapt materials, adjust pacing, and modify instructional strategies could enable them to better address student needs. For example, instructors could incorporate additional examples, tailor assessments, or integrate supplementary resources to support student learning more effectively. These actions align with research by Hegeman (2015), which highlights how instructor-generated resources and personalized teaching strategies in asynchronous math courses can enhance student engagement, reduce attrition, and improve learning outcomes.

Another implication of the findings is the potential value of integrating external college resources to support gateway students. While some students in the study utilized tutoring services, instructors noted that certain students required additional support beyond the traditional role of an instructor. Addressing non-academic factors, such as personal and emotional challenges, can play a crucial role in student success. These findings suggest that enhancing coordination between NVCC's advising center, counseling services, social workers, and tutoring services—particularly with more proactive support tailored for online students—could create a more comprehensive system to help students navigate challenges effectively.

Finally, encouraging the creation of instructor-generated resources, such as video tutorials or problem-solving guides, could address the disconnect students experience with standardized materials and external tools. These personalized resources would better align with course objectives and assessments, enhancing the overall learning experience. Prior studies on multimedia instructional materials (e.g., Choe et al., 2019) suggest that instructor-generated resources can foster engagement and satisfaction, particularly in asynchronous online courses.

In conclusion, these findings call for collaboration, instructional improvements, and targeted support strategies to enhance student success in NOL MTH 161. Supporting student success requires addressing key challenges while equipping instructors with the flexibility to adapt and personalize their teaching strategies. Integrating course presence, through well-designed and aligned instructional materials and assessments, with instructor presence, defined by effective facilitation and personalized support, is crucial for fostering stronger social and cognitive presence in asynchronous environments. Additionally, strengthening connections between instructors and institutional resources—such as academic advising, counseling services, tutoring, and math support centers—can contribute to a more holistic support system for students.

Chapter 5 Recommendations

This study was prompted by a persistent problem of practice at Northern Valley Community College (NVCC): despite the College's ongoing efforts and strategic plan to improve success rates in gateway math courses as a key component of retention, these rates have remained consistently low, fluctuating between 20% and 41% over the past eight years (NVCC Office of Strategic Insights, 2022). In asynchronous online sections of MTH 161 Precalculus I offered through NVCC Online (NOL), the rates of unsuccessful outcomes (grades of D, F, or W) were particularly high. With NVCC anticipating continued growth in online enrollment, addressing these low success rates has become an increasingly pressing priority.

In response to this problem of practice, this study explored student and instructor perceptions of the factors supporting or hindering student learning in NOL MTH 161. Two research questions guided the inquiry:

- Research Question 1: What factors do instructors perceive as supporting or hindering student learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?
- Research Question 2: What factors do students perceive as supporting or hindering their learning in the asynchronous online STEM gateway math course, NOL MTH 161 Precalculus I at NVCC?

To investigate these questions, I employed a qualitative exploratory case study approach, collecting data through student and instructor surveys, semi-structured instructor interviews, and a student focus group. The analysis of this data revealed several key themes, which formed the basis of the findings presented in Chapter 4. These findings, considered alongside the literature reviewed in Chapter 2, informed a set of recommendations for improving NVCC Online's MTH

161 Precalculus I course. This chapter discusses five recommendations for the NVCC Online as it works to enhance learning experiences and outcomes for students in its gateway online math course.

- Recommendation 1: Place a needs assessment strategy in the first two weeks of the course to address varying levels of preparedness to identify gaps in students' knowledge and skills and provide tailored resources and support for early intervention.
- Recommendation 2: Redesign assessments to establish clear alignment between formative and summative assessments and course objectives, ensuring students have practice opportunities that reflect exam rigor and format. Incorporate scaffolded tasks, exemplars, and clear rubrics to communicate expectations for written work.
- Recommendation 3: Encourage meaningful peer collaboration and social interaction by updating discussion prompts, involving instructors in online discussions to offer guidance, and using informal communication tools to help students connect and engage.
- Recommendation 4: Strengthen instructor presence and feedback by improving how feedback is given and creating additional instructor-led materials to better support students throughout the course.
- Recommendation 5: Optimize and integrate support systems for NOL students by fostering collaboration among faculty, advisors, support staff, and administrators to create a more connected and responsive learning environment.

This chapter explores these recommendations in detail, bringing this study to its conclusion. Grounded in the findings from Chapter 4, informed by the literature, and shaped by my perspective as a researcher, these recommendations address both immediate course-level improvements and broader institutional strategies. They range from solutions NOL instructional designers could implement in collaboration with subject matter experts for MTH 161 Precalculus I, to initiatives requiring coordination among faculty, advisors, and support staff to create a comprehensive system of support for online students. The recommendations are presented in the order of a student's journey—starting with entering the course, engaging with learning throughout the term, and concluding with strategies to ensure sustained success.

Recommendation 1: Place a needs assessment strategy in the first two weeks of the course to address varying levels of preparedness to identify gaps in students' knowledge and skills and provide tailored resources and support for early intervention.

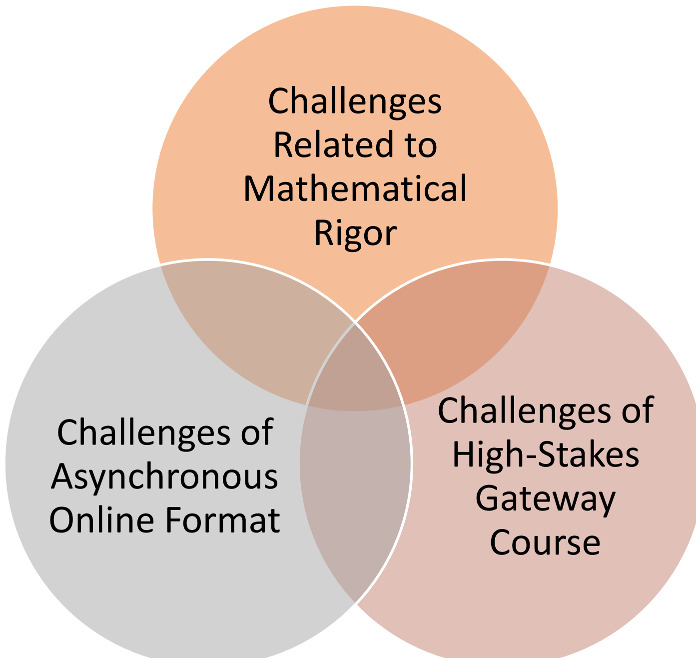
Students enter NOL MTH 161 with varying levels of mathematical preparedness and online learning readiness, both of which significantly impact their ability to succeed. Finding 1 revealed that students with weaker mathematical foundations or limited online learning experience struggled to keep pace, while those with prior exposure to college coursework—whether in-person or online—were better equipped to persist. Students with strong math backgrounds adapted more easily to the asynchronous format, as their confidence in mathematical concepts reduced the cognitive burden of mastering content while adjusting to self-directed learning. Meanwhile, students with structured study habits or prior experience seeking academic support were more likely to manage coursework independently, highlighting the importance of both content knowledge and learning strategies.

The Gateway Math Online Classroom component of the study's conceptual framework (Figure 1.1) highlights that novice online learners often struggle not only with content mastery but also with adapting to the self-directed nature of asynchronous learning. These challenges frequently overlap—for example, a student struggling with mathematical concepts may also lack familiarity with asynchronous learning strategies, increasing their likelihood of falling behind

(Figure 5.1). Early, structured intervention is critical to identifying these obstacles and providing support before they become overwhelming.

Figure 5.1

Key Challenges Impacting Student Success in Asynchronous Gateway Math Courses



Implementing a structured needs assessment—or a gap analysis comparing required skills to students' current abilities—within the first two weeks of the course gives students an early opportunity to assess their readiness, identify challenges, and connect with available support resources. This proactive approach ensures timely guidance, reinforcing students' ability to develop effective learning strategies and persist in the course.

This approach also reflects Teaching Presence on Initial Reaction, which emphasizes how early instructional interventions, accelerated remediation, and just-in-time feedback help students build confidence and engage more effectively with course content. Embedding proactive support early enables instructors to identify student needs and connect them with targeted resources before they fall behind, reducing cognitive overload and improving engagement.

A needs assessment strategy not only enhances Teaching Presence on Initial Reaction by equipping novice online learners with essential tools but also serves as a guiding mechanism within the Cognitive Presence Pool on Learning and Behavior Change. By identifying knowledge gaps early, this strategy helps students progress beyond the Triggered Event stage—where they first engage with content—toward Exploration, Integration, and Resolution. Early, tailored interventions enable students to develop problem-solving strategies, refine study habits, and build confidence in their mathematical abilities. Without structured guidance, struggling students may remain in the Triggered Event stage, aware of their difficulties but unsure how to address them. A structured self-assessment tool facilitates their transition to Exploration, where they begin identifying strategies for improvement, and ultimately to Integration, where they apply these strategies. By embedding proactive support, this approach ensures students actively engage in their learning rather than reactively responding to challenges, increasing persistence and success in the course.

One way to implement this recommendation is by expanding the “Online Environment” discussion in Module 1 to include activities that help students assess their preparedness for both asynchronous learning and mathematical content. Short video clips featuring past students sharing their experiences, challenges, and strategies for success could enhance engagement while reinforcing Social Presence, a key component of the study’s conceptual framework. For example, Sofia, a recent high school graduate, could describe how she used ALEKS to structure her studying and prepare for exams. Abdul, a working parent, could explain how he balanced coursework with his job by attending tutoring sessions and following a structured study plan. Aaliyah could highlight how proactive communication with her professor and student engagement hours helped her succeed. Integrating real student voices strengthens Social

Presence Playground, reinforcing that students are part of a larger learning community with shared challenges and strategies.

Beyond discussion activities, a structured self-assessment tool could help students evaluate their mathematical skills and online learning readiness. This tool could provide targeted recommendations for resources such as ALEKS review modules, tutoring support, or time management strategies for asynchronous coursework. Students who identify significant gaps in their knowledge could access optional skill-building modules in a separate Canvas course, allowing them to revisit key concepts before high-stakes assessments. Weekly workshops on practical skills—such as efficient exam submission, demonstrating all steps to earn full credit, or navigating ALEKS effectively—could serve as just-in-time interventions.

Implementing these strategies would require collaboration among instructional designers, faculty, and subject matter experts, as further discussed in Recommendation 5. By incorporating needs assessments, self-reflection activities, and guided interventions, students can take ownership of their learning early in the course. Over time, as more students complete these assessments, NVCC could gain deeper insights into the challenges faced by NOL MTH 161 students, refining support strategies accordingly.

While the academic rigor of NOL MTH 161 remains high, providing students with early insight into course demands—both mathematical and non-mathematical—empowers them to develop strategies for success. Research on gateway course retention highlights the importance of early intervention, as students who achieve early academic success are more likely to persist. A structured approach to assessing preparedness and providing targeted resources ensures students begin the course with a clear understanding of expectations and the tools needed to succeed. Referring to Gateway Math Online Classroom, Teaching Presence on Initial Reaction, Cognitive Presence Pool on Learning and Behavior Change, and Social Presence Playground within the conceptual framework underscores its role in strengthening engagement, supporting persistence, and fostering success in asynchronous gateway math courses.

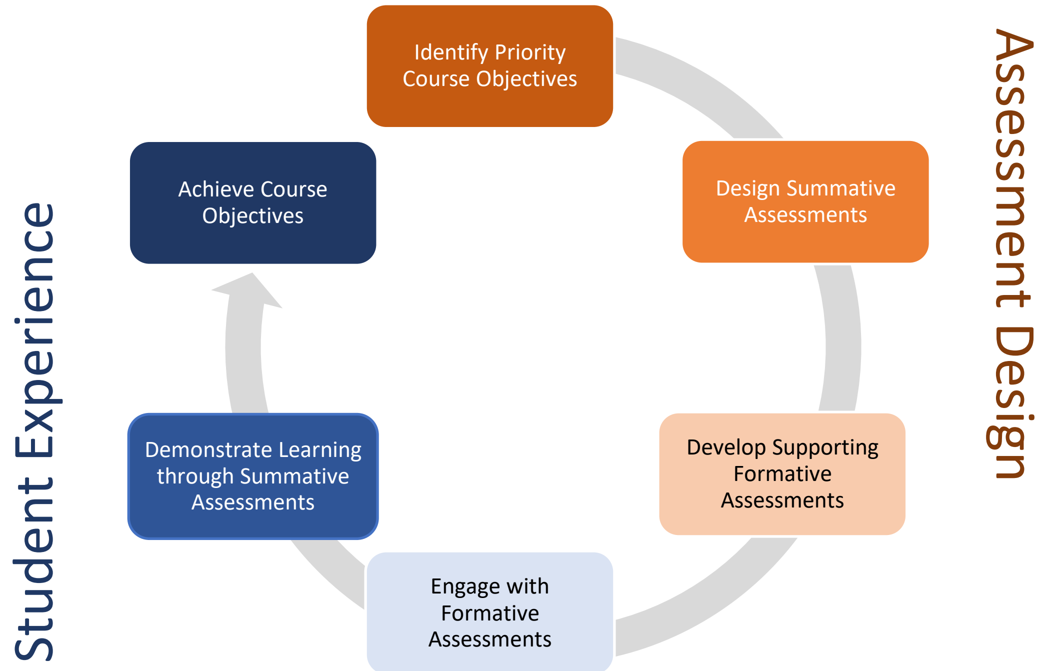
Recommendation 2: Redesign assessments to establish clear alignment between formative and summative assessments and course objectives, ensuring students have practice opportunities that reflect exam rigor and format. Incorporate scaffolded tasks, exemplars, and clear rubrics to communicate expectations for written work.

Sub-finding 2.2 indicated that exams were a major challenge in NOL MTH 161, with both survey and qualitative findings highlighting difficulties related to rigor, time constraints, and misalignment with coursework practice (Figure 4.4). One instructor described exams as a "shock" for students, emphasizing that their practice opportunities did not sufficiently prepare them for the level of complexity and pacing required on assessments. Another instructor observed that a student who had successfully passed NOL MTH 161 struggled in MTH 261, reinforcing concerns that assessments may not effectively measure the skills students need for success in advanced coursework.

Figure 5.2 illustrates how a backward design approach can address these concerns by ensuring summative assessments evaluate key course objectives—such as those critical for success in higher-level math courses like MTH 261 Applied Calculus I—before designing formative assessments that prepare students for high-stakes exams. Students first engage with formative assessments, followed by summative assessments, ultimately achieving course objectives.

Figure 5.2

Aligning Assessment Design with Student Learning Progression



Cognitive Presence Pool on Learning and Behavior Change, from the study's conceptual framework, highlights the progression students undergo as they move from Triggered Events (initial engagement with content) to Exploration, Integration, and ultimately Resolution (where learning is solidified through problem-solving and decision-making). When formative assessments mirror summative expectations, students can develop the skills and confidence needed to transition successfully through these stages. However, when formative assessments do not sufficiently prepare students, they remain in early stages of cognitive engagement—struggling to apply problem-solving skills effectively under exam conditions. Strengthening alignment between assessments ensures that students engage in deeper learning and apply mathematical concepts meaningfully before high-stakes evaluations.

Clear alignment between formative and summative assessments provides students with meaningful opportunities to develop the skills needed for high-stakes exams. Sub-finding 2.2 revealed that many students struggled due to a lack of structured practice that reflected actual exam conditions (Figure 4.4). Survey results quantified this disconnect, with only 42% of students and 17% of instructors agreeing that quizzes and exams accurately assess student learning (Table 4.3). This misalignment suggests that students do not feel adequately prepared by existing coursework, emphasizing the need for stronger alignment between formative and summative assessments to ensure that practice opportunities reflect exam expectations.

To improve student success in NOL MTH 161, assessment redesign should begin by prioritizing essential learning objectives for high-stakes exams. While all course objectives are important, assessing every objective within a limited number of exams is impractical. Collaborating with subject-matter experts, such as MTH 261 instructors, and stakeholders from related STEM programs can help identify the key skills and knowledge students need for future success. This process ensures that summative assessments emphasize critical objectives for advanced coursework and align with the practical needs of students in Information Technology, Business Administration, and other STEM disciplines requiring MTH 161 as a prerequisite.

Once the key objectives are prioritized, summative assessments should be designed to align with these goals and comprehensively assess students' understanding. Exams should include a variety of question types—application-based, conceptual, and procedural—to ensure a well-rounded assessment of learning. Additionally, time constraints should be evaluated and adjusted to give students adequate time to demonstrate their knowledge under realistic conditions.

The development of formative assessments is a cornerstone of this recommendation, as it prepares students for the rigor of exams. Differences in how subject-matter experts present exam questions compared to resources like the eTextbook or ALEKS can cause confusion for novice learners. To address this, formative assessments should include timed quizzes or mock exams that mirror exam conditions, helping students build confidence and familiarity with high-stakes expectations. Exemplars and worked-out examples can further clarify expectations for problem-solving and written work. Additionally, non-graded, low-stakes microlearning videos or interactive workshops targeting commonly misunderstood topics can equip students for exams without adding unnecessary stress.

Teaching Presence, as framed in the conceptual framework, reinforces the role of structured instructional support and instructor feedback in preparing students for summative assessments. Finding 4 emphasized that instructor presence plays a crucial role in student success, particularly in preparing students for exams. Targeted guidance and timely feedback from instructors helped students bridge gaps between coursework and assessments. While this recommendation emphasizes rigor and alignment in course assessment strategy, instructor feedback is a key factor in helping students connect coursework with exam expectations. Feedback on formative work allows students to reflect on their progress and make necessary adjustments before summative assessments. However, reliance on auto-graded ALEKS homework and quizzes delays personalized feedback until the first exam, often too late to intervene effectively. Providing timely, actionable feedback on formative assessments ensures that students receive the support needed to clarify misunderstandings and reinforce problem-solving approaches before high-stakes exams.

This recommendation does not aim to lower the rigor of NOL MTH 161 but to ensure that exam rigor is fully supported by aligned instruction, formative assessments, and scaffolded support. Addressing concerns raised by both instructors and students strengthens the connection between practice and performance, enhancing the course's overall rigor and effectiveness. By explicitly connecting this recommendation to Cognitive Presence Pool on Learning and Behavior Change and Teaching Presence, this strategy reinforces structured learning progression and targeted instructional support, ensuring that students are equipped to apply knowledge effectively in assessments and beyond.

Recommendation 3: Encourage meaningful peer collaboration and social interaction by updating discussion prompts, involving instructors in online discussions to offer guidance, and using informal communication tools to help students connect and engage.

Finding 3 revealed mixed perceptions of social presence and peer collaboration in NOL MTH 161. While some students valued discussion board activities for resource sharing and gaining new perspectives, others found them less effective, often engaging solely to fulfill participation requirements rather than to exchange ideas or deepen their mathematical understanding. Survey results (Table 4.6) revealed that while 67% of instructors believed online discussions supported collaboration and idea exchange, only 32% of students agreed, and just 16% felt that discussions improved their understanding of mathematical concepts. In contrast, focus group participants described informal communication channels as more effective for connecting with peers and exchanging resources. These varying experiences suggest opportunities to redesign peer collaboration activities to foster more purposeful and supportive online learning environments.

The Social Presence Playground from the conceptual framework highlights the role of group cohesion, open communication, and collaboration in fostering meaningful peer engagement. While informal communication naturally supports group cohesion, structured discussion activities are essential for enhancing cognitive engagement and deepening mathematical reasoning. Finding 3 indicated that discussion activities, while engaging, often failed to facilitate meaningful mathematical learning (Figure 4.9). Without structured support, discussions often remain surface-level, limiting their role in fostering deeper learning. Addressing this issue requires an intentional redesign of discussion prompts and facilitation strategies to activate higher levels of cognitive engagement.

I recommend establishing two distinct communication channels for students in NOL MTH 161: one for mathematical sense-making and another for informal interactions. The informal channel could serve as a space for students to connect socially and emotionally, share resources, or express challenges constructively in a supportive environment, fostering a sense of community and affective support. Focus group findings suggest that some students preferred informal settings for interaction, where they felt more comfortable discussing coursework (Focus Group, para. 17). This space could naturally form outside Canvas and be managed by students, or it could take the form of an open forum within Canvas with minimal instructor oversight to encourage organic peer-to-peer interaction.

Simultaneously, math-focused discussion boards on Canvas should have a clear purpose: promoting the exchange of ideas and enhancing understanding of mathematical concepts. Students described discussion boards as primarily spaces for asking logistical questions or reviewing exam materials, rather than engaging in meaningful discourse about mathematical concepts. To address this gap, small-group discussions should feature well-crafted prompts and tasks that activate a broader range of cognitive presence indicators—such as exploration, integration, and resolution.

For example, an error analysis task could align with the NOL MTH 161 course objective to “Perform arithmetic operations on functions, including the composition of functions and the difference quotient.” Understanding the difference quotient in precalculus is essential for building the foundational skills required to use the limit definition of a derivative in calculus. In this task, students could analyze a worked-out solution of finding a simplified difference quotient of a quadratic function, crafted to include common errors and misconceptions, such as mistakes in algebraic simplification or incorrect setups. The worked-out problem could also include missing steps, prompting students to identify unclear transitions. A discussion prompt might ask students to identify correct aspects of the work, find errors, propose corrections, and collaboratively “grade” the solution as if it were an exam item.

Research suggests that open-ended prompts increase the quantity and quality of online interactions (Bradley et al., 2008; Ke & Xie, 2009). Weekly discussions—rather than limiting student engagement to four Exam Review Discussions—could focus on fostering mathematical sense-making. This shift aligns with student feedback that review discussions helped them exchange study resources but did not consistently support deeper mathematical reasoning. By encouraging multiple approaches to problem-solving, articulating reasoning, and making conceptual connections, discussions can shift from passive resource sharing to active cognitive engagement.

Discussion board activities offer an excellent opportunity for students in NOL MTH 161 to engage in deeper learning, yet survey results indicate many students did not feel comfortable participating (Table 4.6). Some focus group participants reported repeatedly seeing the same students comment, which helped them feel more comfortable over time but suggested limited overall engagement. This suggests a need to create prompts that encourage wider participation and help all students feel more confident engaging in discussions.

Instructor participation is essential for fostering productive, meaningful discussions that enhance mathematical thinking. Finding 3 indicated that some students found discussions useful for reviewing problems, but participation dropped as the semester progressed. Instructors can help sustain engagement by actively guiding discussions—clarifying misconceptions, posing thought-provoking questions, or providing hints or clues to differentiate instruction. These efforts prevent the reinforcement of incorrect understandings while supporting students in navigating challenging concepts.

Leveraging informal communication channels alongside redesigned math-focused discussion boards fosters a more connected and collaborative course environment. Encouraging structured peer interactions and active instructor facilitation ensures that discussions remain productive and conceptually rich, supporting deeper learning and engagement. These enhancements help students develop problem-solving skills and mathematical reasoning essential for success in the course and beyond.

Recommendation 4*: *Strengthen instructor presence and feedback by improving how feedback is given and creating additional instructor-led materials to better support students throughout the course.

Instructor presence is critical for fostering student success, as evidenced by research on gateway math courses and corequisite support models. Just-in-time pedagogical support—including tailored instruction, proactive engagement, and supplemental resources—enhances conceptual understanding and reduces anxiety (Kim, 2016; Mireles et al., 2014). Corequisite models demonstrate how integrated instructor support boosts pass rates and strengthens self-efficacy (Logue et al., 2017). Additionally, multimedia resources, such as instructor-created videos, have been shown to significantly improve engagement and clarify complex topics (Choe et al., 2019). These evidence-based practices highlight the pivotal role of instructor presence in bridging standardized course materials with individual student needs, fostering deeper learning and academic confidence.

Finding 4 revealed that instructor presence significantly shaped student experiences and outcomes in NOL MTH 161, with accessibility, responsiveness, and proactive engagement contributing to student success. However, the effectiveness of instructor presence varied, and gaps in feedback utilization, limited real-time interaction, and constraints imposed by the standardized course design hindered instructors' ability to fully support all students. Three key themes—Instructor Support, Feedback, and Adaptability & Personalization—guided this finding, highlighting both the strengths and limitations of instructor presence. This recommendation focuses on improving feedback practices, increasing instructional flexibility, and offering targeted professional development opportunities to enhance teaching presence and student learning.

Feedback plays a vital role in student growth by enabling reflection, adjustments, and meaningful learning. However, for feedback to be effective, it must be actionable, clear, and timely. Sub-finding 4.2 revealed a disconnect between instructor feedback efforts and student perceptions of its usefulness. While 83% of instructors reported providing timely feedback, only 63% of students agreed, and just 37% found feedback on assignments helpful for improving their understanding. Additionally, some students expressed frustration over the lack of detailed feedback on exams, which limited their ability to reflect on mistakes and improve for future assessments.

Developing best practices for effective feedback—such as providing targeted, actionable comments—can help instructors ensure feedback is not only constructive but also aligned with course goals. One potential approach is incorporating audio or video feedback, which has been shown to enhance instructor presence and improve engagement with feedback. Additionally, embedding formative assessments with structured feedback loops earlier in the semester, as outlined in Recommendation 2, would ensure that students receive multiple opportunities to engage with feedback before high-stakes exams. These strategies reflect the Teaching Presence component of the conceptual framework, which emphasizes the role of structured instructional design, facilitation, and feedback in guiding students toward deeper learning.

Sub-finding 4.2 highlighted that some instructors felt constrained by the rigid course structure, limiting their ability to personalize instruction. The fixed pacing prevented them from adjusting lessons to better support struggling students or emphasize key concepts needed for future coursework, such as calculus. While standardized materials ensure consistency, they restrict differentiation and adaptability. Expanding instructional flexibility—allowing instructors to supplement materials with additional examples, explanations, or videos—could improve learning experiences. This would also address student concerns about misalignment between instructional materials and assessments, as one student noted ALEKS problems were significantly more difficult than coursework.

Providing instructors with opportunities to create supplemental instructional materials, design additional problem-solving exercises, or offer structured review sessions would better support students' learning. Additionally, offering students the opportunity to engage with instructor-created content—such as guided solution videos or interactive problem-solving sessions—could bridge the gap between coursework and assessment expectations. This approach strengthens both Teaching Presence and Cognitive Presence by ensuring that students receive not only structured instruction but also the opportunity to engage deeply with mathematical concepts through instructor-led materials and timely feedback.

To equip NOL MTH 161 instructors with the tools to supplement instruction, provide impactful feedback, and differentiate learning experiences, professional development opportunities should be prioritized. Sub-finding 4.1 revealed that proactive instructor communication, structured review sessions, and student engagement hours (office hours) were key factors in student success. However, while 83% of instructors indicated that they often or always offered office hours, only 47% of students agreed, and 26% reported that their professor rarely or never provided such support. This gap in awareness or engagement suggests that more structured outreach and better communication about instructor availability could encourage greater student participation.

One approach to strengthening instructor presence and collaboration is establishing weekly instructor meetings or small working groups where instructors can share strategies, discuss student challenges, and develop shared resources. Over time, this could expand into formalized training on feedback strategies, differentiation techniques, and instructional engagement. Additionally, participation in conferences and workshops focused on online teaching and math pedagogy could further equip instructors with best practices tailored to gateway math courses.

Instructor presence serves as the bridge between standardized course materials and student engagement, reinforcing both the Teaching Presence and Cognitive Presence elements of the conceptual framework. By improving feedback practices, increasing instructional flexibility, and investing in instructor development, the course can better support students in navigating the challenges of online learning and mathematical problem-solving. These strategies align with student and instructor feedback from Finding 4, reinforcing the need for personalized, structured, and proactive engagement in the course.

While instructor efforts play a crucial role in shaping student experiences, broader institutional support is also needed to enhance learning systems and optimize student support resources. The final recommendation focuses on strengthening institutional-level collaboration to improve student support systems in NOL MTH 161, ensuring a more connected and responsive learning environment.

Recommendation 5*: *Optimize and integrate support systems for NOL students by fostering collaboration among faculty, advisors, support staff, and administrators to create a more connected and responsive learning environment.

Supporting NOL MTH 161 students requires a collaborative effort that goes beyond individual instructors or isolated redesign initiatives. Finding 1 revealed that students entered the course with widely varying levels of mathematical preparedness and online learning readiness, affecting their ability to keep pace. Some struggled with the asynchronous format, seeking real-time support or relying on external resources like private tutoring. Finding 4 highlighted that instructors also faced challenges balancing instructional responsibilities with student support, including advising and addressing non-academic barriers. Additionally, the unique barriers faced by community college students—particularly those who opt for asynchronous courses due to flexibility—highlight systemic gaps that extend beyond individual efforts.

Recognizing student needs and connecting them to appropriate support services is essential for their success in NOL MTH 161. Finding 2 demonstrated that many students struggled with exams due to misalignment between coursework and assessments, leaving them feeling unprepared for high-stakes conditions. These students enroll with the intent to succeed but face barriers that cannot be resolved by individual instructors or students alone. Instead, a coordinated support system can share responsibilities, lightening the burden and improving student success. Addressing these challenges aligns with NVCC's strategic priorities, which emphasize timely completion of gateway courses. Strengthening institutional collaboration offers an opportunity to secure leadership buy-in and engage faculty, advisors, support staff, and administrators in improving student support structures.

This recommendation proposes enhancing existing student resources—such as success coaches, counseling, tutoring, and workshops—by improving their integration, accessibility, and utilization within the course structure. Expanding institutional-level social presence, as reflected in the Social Presence Playground of the conceptual framework, can foster structured peer collaboration and engagement. Finding 3 highlighted that while peer collaboration had benefits, students often did not engage meaningfully with discussion boards, instead seeking support elsewhere. Strengthening structured academic and social support—such as faculty mentorship programs, peer-led study groups, and college-wide engagement initiatives—can enhance both social and academic integration. Embedding support directly into the student experience and regularly assessing its effectiveness will ensure these resources are utilized effectively.

Evaluating and optimizing current resources is critical to ensuring they effectively support NOL MTH 161 students. Finding 4 indicated that some students struggled to access support due to limited awareness or uncertainty about how to seek help. Understanding why students may not engage with specific resources can inform strategies to make them more accessible and relevant. Continuous evaluation ensures that the support system adapts to emerging needs and remains effective over time. Increasing awareness and accessibility is also essential, as Finding 1 revealed that students unfamiliar with online learning often struggled with self-directed learning. A "Week 0" module within NOL MTH 161 could introduce key support services early in the semester, helping students engage with available resources from the start. Targeted awareness campaigns—such as Canvas announcements and course-integrated materials—could further bridge this gap and encourage student participation in support services.

Customizing student support is essential, as generic resources may not fully address the unique challenges of NOL MTH 161. Finding 2 emphasized the need for structured formative assessments and targeted exam preparation. Collaborating with the NVCC Tutoring Center to train staff on common struggles, offering targeted workshops on high-challenge topics, or creating a peer-led mentorship program can provide tailored assistance that directly aligns with student needs. Embedding support directly into the course structure can also strengthen cognitive engagement. Finding 3 revealed that discussion boards were primarily used for resource sharing rather than mathematical discourse, suggesting that better-designed collaborative support mechanisms could enhance student learning. Providing weekly reminders about workshops or tutorials tied to specific course content could make these resources more relevant and timely. Additionally, Finding 4 highlighted that proactive instructor engagement and structured review sessions contributed to positive student outcomes. Personalized outreach, such as automated notifications or emails triggered by low quiz scores or missed assignments, could help students connect with support services before they fall behind. While NVCC already employs an early alert system, automating these processes through the learning management system could reduce the burden on instructors and improve timeliness.

A more integrated and proactive institutional support system could be established through an interdisciplinary "Tiger Team" comprising math faculty, first-year advisors, IT staff, tutoring professionals, and college leadership. This team would meet regularly to review student needs, share insights, and implement coordinated strategies. Finding 4 revealed that instructors often took on advising responsibilities beyond their formal teaching roles, bridging gaps where institutional support was lacking. A unified support system would foster seamless collaboration among stakeholders, ensuring that students receive timely, coordinated assistance to navigate academic challenges. The Teaching Presence component of the conceptual framework highlights how well-integrated instructional and institutional support structures can facilitate proactive engagement, ensuring that students receive timely interventions and resources tailored to their learning challenges.

This recommendation does not propose creating entirely new services but rather leveraging and enhancing existing resources through strategic collaboration and thoughtful integration. Strengthening social presence expands peer networks, enhancing cognitive presence through structured learning supports and reinforcing teaching presence by embedding instructional guidance. By optimizing these support mechanisms and embedding them directly into the student experience, NVCC can ensure that NOL MTH 161 students receive the resources they need to succeed in an asynchronous learning environment.

Conclusion

This chapter presents five recommendations aimed at addressing the problem of practice identified in this study: supporting student success in NOL MTH 161, an asynchronous gateway math course at Northern Valley Community College (NVCC). Grounded in the findings of this case study and supported by relevant literature, the recommendations focus on improving course-level practices, course design, and broader institutional strategies to better meet the needs of NOL MTH 161 students.

The first recommendation highlights early needs assessments to identify gaps in students' preparedness within the first two weeks, enabling tailored early interventions that support early momentum and long-term success. The second focuses on aligning formative and summative assessments with course objectives through scaffolded tasks, exemplars, and rubrics, ensuring students are better prepared for high-stakes exams. The third recommendation emphasizes enhancing peer collaboration and social presence by improving discussion prompts, incorporating instructor guidance, and utilizing informal communication tools to foster meaningful engagement. The fourth prioritizes strengthening instructor presence and feedback by refining feedback practices, increasing instructional flexibility, and providing professional development to bridge the gap between standardized materials and varying student needs. Lastly, the fifth recommendation advocates for optimizing and integrating support systems through institutional collaboration, ensuring a coordinated and adaptive approach to addressing the systemic gaps that impact NOL MTH 161 students.

These recommendations collectively address the problem of practice by targeting the critical challenges identified by students and instructors in NOL MTH 161. By integrating structured interventions that support learning progression, strengthening instructor engagement, and reinforcing peer collaboration, these strategies align with key elements of the Community of Inquiry framework and the study's conceptual framework. They aim to create a supportive and adaptive learning environment that accommodates varying levels of preparedness, fosters meaningful collaboration, and enhances instructor presence. By aligning assessments with course objectives and integrating coordinated institutional support, the recommendations provide a holistic framework to improve student outcomes and ensure sustained success in this gateway course.

In the local context of NVCC, these recommendations align with the college's strategic priorities and directly benefit its broad student population. NVCC serves a broad demographic, including students balancing multiple responsibilities such as work and family, those returning to education after significant gaps, and first-generation college students. Many of these students choose asynchronous online courses for their flexibility but face unique challenges such as limited preparedness, reduced access to on-campus resources, and fewer opportunities to build social capital. These recommendations reinforce NVCC's commitment to student success by embedding structured, proactive support into the learning experience, equipping students with the tools needed to persist and thrive.

These efforts not only enhance student outcomes in NOL MTH 161 but also contribute to the college's broader retention and completion goals, as emphasized in its strategic plan. By improving success rates in gateway courses, NVCC can strengthen early momentum for students, laying the foundation for long-term academic and career success. These recommendations also benefit faculty by providing clearer frameworks, professional development, and collaborative support, enabling them to meet the demands of online teaching more effectively.

While these recommendations offer actionable strategies to address the problem of practice, several limitations must be acknowledged. Implementing these changes will require significant collaboration and resource allocation, which may pose challenges in terms of faculty workload, budget constraints, and institutional buy-in. Additionally, while tailored interventions, redesigned assessments, and enhanced support systems aim to support a broad range of student needs, the asynchronous nature of NOL MTH 161 may still limit the immediacy of certain supports. Finally, the recommendations rely on continuous evaluation and adaptation, which will require sustained commitment from stakeholders to ensure their long-term effectiveness. Despite these challenges, the potential benefits for students, faculty, and NVCC's broader mission make these efforts both necessary and worthwhile.

The challenges of asynchronous gateway math courses are complex, but with thoughtful improvements at both the course and institutional levels, NVCC can better support students in NOL MTH 161. By embedding structured interventions, fostering engagement, and creating stronger institutional alignment, these recommendations serve as a roadmap for improving student success in online gateway math. Implementing these strategies not only strengthens student learning outcomes in NOL MTH 161 but also contributes to a more effective and sustainable approach to online education at NVCC.

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Appendices

Appendix A – Instructor Survey Invitation Email

Dear [NOL MTH 161 Instructor's Name],

I hope this email finds you well. My name is Soo Son, and I am currently pursuing my doctorate in education at the University of Virginia. As a former full-time math instructor, I am focusing my capstone research project on asynchronous online gateway math courses.

I am reaching out to invite you to participate in a research study exploring perceptions and experiences in teaching NOL MTH 161 Precalculus I. The purpose of this study is to gain insights into the experiences of both students and instructors in online math courses, specifically focusing on factors that support or hinder student learning.

Your participation would involve:

1. Completing a brief online survey about your experiences teaching NOL MTH 161, which will take approximately 10 minutes.
2. Indicating your availability to participate in a semi-structured interview during the second or third week of November, if you are interested. The interview will take approximately 30 minutes.

The total time commitment for both the survey and the interview is about 40 minutes. As a token of appreciation, instructors who participate in both the survey and the interview will receive a $25 gift card.

Your participation is entirely voluntary, and your responses will be anonymized and kept confidential. Your insights will be invaluable in contributing to our understanding of online math education and improving student success in these courses.

If you are interested in participating, please complete the survey by following the link below. Additionally, if you are available for the interview, please indicate your availability in the survey.

Please feel free to reach out if you have any questions or need further information. Thank you for considering this invitation, and I look forward to your participation.

Best regards,
Soo Son
Doctoral Student
University of Virginia
School of Education and Human Development
Nhv2as@virginia.edu
IRB-SBS 6965

Appendix B – Student Survey Invitation Email

Dear [NOL MTH 161 Instructor's Name],

I hope this email finds you well. My name is Soo Son, and I am currently pursuing my doctorate in education at the University of Virginia. As a former full-time math instructor, I am focusing my capstone research project on asynchronous online gateway math courses.

I am reaching out to invite you to participate in a research study exploring perceptions and experiences in teaching NOL MTH 161 Precalculus I. The purpose of this study is to gain insights into the experiences of both students and instructors in online math courses, specifically focusing on factors that support or hinder student learning.

Your participation would involve:

1. Completing a brief online survey about your experiences teaching NOL MTH 161, which will take approximately 10 minutes.
2. Indicating your availability to participate in a semi-structured interview during the second or third week of November, if you are interested. The interview will take approximately 30 minutes.

The total time commitment for both the survey and the interview is about 40 minutes. As a token of appreciation, instructors who participate in both the survey and the interview will receive a $25 gift card.

Your participation is entirely voluntary, and your responses will be anonymized and kept confidential. Your insights will be invaluable in contributing to our understanding of online math education and improving student success in these courses.

If you are interested in participating, please complete the survey by following the link below. Additionally, if you are available for the interview, please indicate your availability in the survey.

Please feel free to reach out if you have any questions or need further information. Thank you for considering this invitation, and I look forward to your participation.

Best regards,
Soo Son
Doctoral Student
University of Virginia
School of Education and Human Development
Nhv2as@virginia.edu
IRB-SBS 6965

Appendix C – Instructor Survey Questions

Thank you for participating in this survey. Your feedback is invaluable in helping us understand and improve the NOL MTH 161 Precalculus I course. The survey consists of rating items and a few open-ended questions. It should take about 10 minutes to complete. Please answer each question honestly based on your experience teaching this course. Your responses will remain confidential and will be aggregated for analysis. If you're interested in participating in a one-on-one interview, you can provide your contact information at the end.

By continuing to complete the survey, you are agreeing to participate in this study.

Section 1: Course Content and Design

1. For each statement, please indicate your level of agreement by selecting the option that best reflects your experience teaching NOL MTH 161 Precalculus I during Fall 2024. If you have taught this course in previous semesters, please focus on your experience in Fall 2024.

Activity	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The instructional materials help students understand mathematical concepts.	☐	☐	☐	☐	☐
The modules are well-organized and easy to follow.	☐	☐	☐	☐	☐
The syllabus clearly explains the course goals and expectations.	☐	☐	☐	☐	☐
The quizzes and exams accurately assess student learning.	☐	☐	☐	☐	☐

Section 2: Instructor Facilitation

2. Please indicate how often you engage in the following activities to support student learning in NOL MTH 161 I during Fall 2024. If you have taught this course in previous semesters, please focus on your experience in Fall 2024.

Activity	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
Posting weekly announcements to help students stay on track	☐	☐	☐	☐	☐
Sending reminder emails about upcoming deadlines	☐	☐	☐	☐	☐
Creating and/or sharing supplemental instructional materials to enhance student understanding	☐	☐	☐	☐	☐
Offering office hours to provide additional support	☐	☐	☐	☐	☐
Organizing extra review sessions to reinforce learning	☐	☐	☐	☐	☐
Providing detailed feedback on assignments within one week to help students improve their understanding	☐	☐	☐	☐	☐

Section 3: Student Engagement

3. For each statement, please indicate your level of agreement based on your experience teaching NOL MTH 161 Precalculus I during Fall 2024. If you have taught this course in previous semesters, please focus on your experience in Fall 2024.

Activity	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The Introduction Discussion Board helps students feel connected to the course.	☐	☐	☐	☐	☐
My students are comfortable participating in online discussions.	☐	☐	☐	☐	☐
Online discussions help students collaborate and exchange ideas.	☐	☐	☐	☐	☐
Online discussions contribute to students’ understanding of mathematical concepts.	☐	☐	☐	☐	☐

Section 4: Open-Ended Questions

4. Based on your observation of student performance and engagement, what aspects of this course helped students succeed? What positive outcomes did you notice?

5. Based on your observation of student performance and engagement, what aspects of this course made it harder for students to succeed? What challenges or negative outcomes did you notice?

6. How does the overall design of NOL MTH 161 support or hinder student learning? Please provide examples or suggestions for changes or improvements.

Section 5: One-on-One Interview Invitation

We are inviting instructors to participate in a 30-minute one-on-one interview to discuss your experiences with NOL MTH 161. Participants will receive a $25 gift card as a token of appreciation. If you’re interested, please provide your name and email below. Your survey responses will remain confidential, and your contact information will only be used to invite you to the interview.

Name: ________________________

Email: ________________________

Appendix D – Student Survey Questions

Instructions: Thank you for participating in this survey. Your feedback is invaluable in helping us understand and improve the NOL MTH 161 Precalculus I course. This is not a course evaluation, but rather a survey aimed at gathering insights on your experience to help inform research and course improvements. It should take about 10 minutes to complete. Your responses will remain confidential. If you provide your contact information for the focus group at the end, it will only be used for that purpose.

Section 1: Course Content and Design

1. For each statement, please indicate your level of agreement by selecting the option that best reflects your experience in the NOL MTH 161 Precalculus I course during the Fall 2024 semester. If you are retaking the course, please focus on your experience this semester.

Statements	Strongly Disagree	Disagree	Neutral	Agree	Strongly Agree
The instructional materials helped me understand mathematical concepts.	◻	◻	◻	◻	◻
Canvas modules are well-organized and easy to follow.	◻	◻	◻	◻	◻
The course goals and expectations were clearly explained in the syllabus.	◻	◻	◻	◻	◻
The quizzes and exams matched what we learned in the course.	◻	◻	◻	◻	◻

Section 2: Instructor Facilitation

2. For each statement, please indicate your level of agreement by selecting the option that best reflects your experience in the NOL MTH 161 Precalculus I course during the Fall 2024 semester. If you are retaking the course, please focus on your experience this semester

Statements	**Never**	**Rarely**	**Sometimes**	**Often**	**Always**
My professor posted weekly announcements to help me stay on track	◻	◻	◻	◻	◻
My professor sent reminder emails about upcoming deadlines	◻	◻	◻	◻	◻
My professor created and/or shared supplemental instructional materials to enhance my understanding	◻	◻	◻	◻	◻
My professor offered office hours to provide additional support	◻	◻	◻	◻	◻
My professor organized extra review sessions to reinforce learning	◻	◻	◻	◻	◻
My professor provided timely feedback on assignments	◻	◻	◻	◻	◻
The feedback on assignments was helpful for improving my understanding	◻	◻	◻	◻	◻

Section 3: Student Engagement

3. **For each statement, please indicate your level of agreement based on your experience in the NOL MTH 161 Precalculus I course during Fall 2024.**

Statements	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The Introduction Discussion Board helped me feel connected to the course	□	□	□	□	□
I felt comfortable participating in online discussions	□	□	□	□	□
Online discussions helped me collaborate with classmates and exchange ideas	□	□	□	□	□
Online discussion enhanced my understanding of mathematical concepts	□	□	□	□	□

Section 4: Overall Satisfaction and Learning Experience

4. For each statement, please indicate your level of agreement by selecting the option that best reflects your experience in the NOL MTH 161 Precalculus I course.

Statements	**Strongly Disagree**	**Disagree**	**Neutral**	**Agree**	**Strongly Agree**
The course activities kept me interested and engaged.	□	□	□	□	□
I can use what I learned in this course in other areas of my studies or life.	□	□	□	□	□
This course helped me develop useful skills or knowledge.	□	□	□	□	□
Overall, I’m satisfied with the course content.	□	□	□	□	□
Overall, I’m satisfied with the support my professor provided, including feedback, availability, and additional resources.	□	□	□	□	□

5. What specific aspects of this course (such as assignments, resources, course design, policies, interactions with the instructor and peers, or any other elements) contributed to a successful experience for you? Please share any moments or examples where these made a positive difference for you.

6. What specific aspects of this course (such as assignments, resources, course design policies, interactions with the instructor and peers, or any other elements) made it more challenging for you? Please describe any moments or examples where these factors led to difficulties or negative outcomes.

Section 4: Demographics

This section asks about your general background and readiness for the course.

7. Are you a full-time student?
    - ☐ Yes
    - ☐ No

8. How ready did you feel to take MTH 161 Precalculus I (math readiness)?
    - □ Very Ready
    - □ Ready
    - □ Neutral
    - □ Not Very Ready
    - □ Not Ready at All

9. How ready did you feel to take an online course (asynchronous readiness)?
    - □ Very Ready
    - □ Ready
    - □ Neutral
    - □ Not Very Ready
    - □ Not Ready at All

Focus Group Participation:
We're inviting students to join a focus group to share more about their experience. If you're interested, please provide your name and email below. You'll receive a $25 gift card for participating. Your survey answers will remain confidential, and your contact information will only be used to invite you to the focus group.

Name: ________________________

Email: ________________________

Thank you for your participation. This completes the survey!

Appendix E – Instructor Focus Group Discussion Invitation Email

Subject: Invitation to Participate in Focus Group Discussion on NOL MTH 161 Precalculus I

Dear [Instructor's Name],

I hope this email finds you well. Thank you for completing the survey and expressing your interest and availability to participate in a focus group discussion for my research study.

Based on your survey response, I am pleased to invite you to participate in a focus group discussion on October XX at XX time. This session will take approximately 30 minutes and will be conducted via Zoom. The purpose of the focus group is to further explore your experiences and perceptions of teaching NOL MTH 161 Precalculus I, focusing on factors that support or hinder student learning in the asynchronous online format.

Your insights and contributions will be invaluable in enhancing our understanding of online math education and improving student success in these courses. As a token of appreciation for your participation, you will receive a $25 gift card upon completion of the focus group discussion.

Please confirm your availability for the focus group discussion by replying to this email by October XX. If you have any questions or need further information, feel free to reach out.

Thank you once again for your willingness to contribute to this important research. I look forward to your participation.

Best regards,

Soo Son
Doctoral Student
University of Virginia
School of Education and Human Development
Nhv2as@virginia.edu

Appendix F – Student Focus Group Discussion Invitation Email

Subject: Invitation to Participate in Focus Group Discussion for NOL MTH 161 Students

Dear [Student's Name],

I hope this email finds you well. My name is Soo Son, and I am a doctoral student at the University of Virginia's School of Education and Human Development. As part of my research study on online gateway math courses, I am conducting a focus group discussion to gather insights from students who have taken NOL MTH 161 Precalculus I at Northern Valley Community College (NVCC) Online.

Your academic achievements and experiences make you an ideal candidate for this discussion. I would like to invite you to participate in a focus group discussion where we will explore various aspects of your experience in NOL MTH 161, including your perceptions, challenges, and suggestions for improvement.

The focus group discussion will take place on [proposed date(s) and time(s)]. Please let me know your availability by responding to this email with your preferred date(s) and time(s) by [deadline]. If none of the proposed dates work for you, please suggest an alternative time, and I will do my best to accommodate.

As a token of appreciation for your time and participation, you will receive a **$25 gift card**. Your insights will be invaluable in shaping the future of online gateway math courses at NVCC.

Thank you for considering this invitation. I look forward to your response and the opportunity to discuss your experiences in NOL MTH 161.

Best regards,

Soo Son
Doctoral Student
University of Virginia
School of Education and Human Development
Nhv2as@virginia.edu

Appendix G – Instructor Interview Protocol

Prior to Focus Group Discussion:

- Send Zoom Meeting Link two days before to participants for confirmation and reminder.
- Start the Zoom meeting early to check sound, audio, and webcam.

Location: Zoom

Date: 3rd or 4th week of November

Participants: Selected NOL MTH 161 Instructors

Researcher Conducting Session: Soo Son

Introduction: Thank you for joining me today. I am conducting this interview as part of my research on understanding the factors that support or hinder student learning in NOL MTH 161 Precalculus I. I am interested in learning about your experiences as an instructor, particularly what you believe helps students succeed or, alternatively, what makes it harder for them to do well in the course.

Audio Recording Instructions: This interview should take about 30 minutes, and I'll be recording it, with your permission, to ensure accuracy. Your responses will remain confidential. Do you have any questions before we start? If not, let's begin with the first question.

Interview Questions

1. **Perceptions of Successful Moments** – Based on your experience teaching this course, can you describe a moment when you felt your students were particularly successful? What was happening, and how did you recognize that success?
   a. How do you think course organization and student collaboration through discussions contributed to this success?
2. **Factors Supporting Success** – What do you believe were the key factors that supported student success in that moment? Were there specific activities, interactions, or course elements that helped?
3. **Challenges and Barriers to Success** – Can you recall a time when students were struggling or not as successful in the course? What did you observe, and what do you think contributed to that struggle?
4. **Evidence of Success or Struggle (Feedback and Learning)** – When students do well or struggle, how do you know? What signs, behaviors, or outcomes help you identify success or challenges in their learning?
   a. How does feedback play a role in identifying and addressing these struggles?"

5. **Reflection on Improvement** – What changes or improvements do you think could be made to the course to create more successful learning experiences for your students? What would help reduce the barriers you've observed

Note: These questions may be updated based on the analysis of survey data to identify critical factors from Phase 1 of data collection. For example:

If the survey reveals instructional materials or modules as effective or challenges, then I can ask "In the survey, several instructors mentioned that ____ either supported or hindered student learning. Can you tell me more about your experience with this? What do you think made it effective or difficult for students?

If feedback is found to be a key factor in success, then I can ask "Some instructors highlighted feedback as a key factor in student success. Can you provide an example of how your feedback has helped a student improve, or when it didn't work as expected? What do you think made the difference?"

If engagement in discussions or activities varies widely, then I can ask "Survey responses indicated that student participation in online discussions can either be highly engaging or quite limited. How do you approach encouraging student participation, and what have you found works well or not so well in promoting engagement?"

Concluding Interview:

Thank you for sharing your insights today. Your input is invaluable for helping us understand the factors that support or hinder student learning in this course. Before we conclude, if you have any additional thoughts or documents related to our discussion, please feel free to email them to me at nhv2as@virginia.edu. Examples of documents I would be interested in include course syllabi, lesson plans, instructional guides, assignment prompts, feedback you've provided to students, or general class announcements. Please ensure that any materials you share do not include student work or any other information that could identify individual students, even if redacted. I will also be sending a consent form to invite you to submit any of these artifacts, which you can review before deciding to share them.

I'll be sending the interview transcript for your review and feedback. You'll also receive the final report in December. Thank you again for your time and participation. If you have any questions or further thoughts after today's discussion, don't hesitate to reach out.

Appendix H – Student Focus Group Protocol

Prior to Focus Group Discussion:

- Send Zoom Meeting Link two days before to participants for confirmation and reminder.
- Start Zoom meeting and check sound, audio, and webcam.

Location: Zoom

Date: Week of December 2

Participants: Selected NOL MTH 161 Students

Researcher Conducting Session: Soo Son

Introduction: Thank you for joining today. My name is Soo Son, and I'm conducting this focus group as part of my research on understanding what supports or hinders student learning in NOL MTH 161. I'm particularly interested in hearing about your experiences, what has helped you succeed, and what challenges you've faced in the course. This session will last about 30 minutes, and I'd like to record it for accuracy, with your permission. All your comments will remain confidential. Do you have any questions before we begin?

Facilitating the Focus Group Discussion:

- Encourage Participation: "Let's hear from everyone. [Student's Name], what are your thoughts?"
- Manage Dominant Participants: "Thanks, [Student's Name]. I'd like to hear from others now."
- Keep the Discussion on Track: "That's an interesting point. How does it relate to your experience in NOL MTH 161?"
- Address Conflicting Opinions: "Great to hear different perspectives. [Student's Name], what do you think?"

Focus Group Questions:

6. **Perceptions of Successful Moments** – Can you share a specific moment in this course where you felt confident in what you were learning? What was happening, and how did you know it was a successful moment?

7. **Factors Supporting Success** – What do you think helped you reach that point of success? Were there particular materials, feedback, or interactions that made a difference?

8. **Challenges and Struggles** – Can you describe a time in the course when you felt like you were struggling or not doing well? What made that moment challenging?
9. **Instructor and Peer Interaction** – How did your interactions with the instructor or other students affect your learning? Were there times when these interactions helped you, or made things harder?
10. **Reflection on Improvement** – If you could change one thing about the course to help students succeed, what would it be? How do you think that change would create more successful learning experiences?

Note: These questions may be updated based on the analysis of survey data to identify critical factors from Phase 1 of data collection. For examples:

If the survey reveals that students found specific modules particularly difficult, then I can ask "In the survey, many students mentioned that Module [X] was especially challenging. Can you share your experience with this module? What made it difficult, and how did you try to overcome those challenges?"

If the survey indicates that instructor feedback played a major role in student success, then I can ask "The survey responses highlighted the importance of instructor feedback. Can you describe how feedback from your instructor either helped or hindered your learning in the course?"

If the survey shows that students had mixed experiences with quizzes and exams, then I can ask "In the survey, some students mentioned that quizzes and exams either helped or hindered their learning. How did you feel about the quizzes and exams in this course? What aspects were helpful, and what made them challenging?"

Concluding Focus Group Discussion:

Thank you all for sharing your valuable insights today. Your input is incredibly helpful for my research. Before we conclude, if you have any documents or materials related to our discussion that you'd like to share, please email them to me at nhv2as@virginia.edu. Examples of documents I would be interested in include your own notes, reflections on the course, or any personal study materials you've created that helped you succeed in NOL MTH 161. Please ensure that any materials you share do not include information from or about other individuals, such as feedback from an instructor on your work or communications that identify specific classmates. I will be sending an email with a consent form to invite you to submit any of these artifacts, which you can review before deciding whether to share them.

I'll be sending the focus group transcript for your review and feedback. You'll also receive the final report in December. Thank you again for your time and participation. If you have any questions or thoughts after the discussion, please feel free to reach out.

Appendix I – Document and Artifact Collection Invitation Email

For Instructors

Subject: Request for Additional Materials for NOL MTH 161 Research Study

Dear [Instructor's Name],

I hope this email finds you well. Thank you once again for participating in our recent focus group discussion for the NOL MTH 161 Precalculus I course. Your insights have been invaluable to our research.

As we continue to delve deeper into understanding the factors that support or hinder student learning in this course, we would greatly appreciate your assistance in providing additional materials. Specifically, we are seeking any documents or artifacts that you believe are relevant to our discussion and can provide further context to your experiences and perspectives.

Examples of such materials include:

- Course syllabi
- Lesson plans
- Discussion board prompts and student interactions
- Assignment guidelines and rubrics
- Feedback provided to students
- Any other instructional materials you have used

Please rest assured that all materials will be handled with the utmost confidentiality, and any personal identifiers will be removed.

You can email these documents directly to me at nhv2as@virginia.edu.

If you have any questions or need further clarification, please do not hesitate to contact me. Your contributions are highly valued and will significantly enhance the depth of our study.

Thank you for your continued support and cooperation.

Best regards,

Soo Son
Doctoral Student
University of Virginia
School of Education and Human Development
nhv2as@virginia.edu

For Students

Subject: Request for Additional Materials for NOL MTH 161 Research Study

Dear [Student's Name],

I hope this email finds you well. Thank you once again for participating in our recent focus group discussion for the NOL MTH 161 Precalculus I course. Your insights have been invaluable to our research.

As we continue to delve deeper into understanding the factors that support or hinder student learning in this course, we would greatly appreciate your assistance in providing additional materials. Specifically, we are seeking any documents or artifacts that you believe are relevant to our discussion and can provide further context to your experiences and perspectives.

Examples of such materials include:

- Notes or reflections on the course
- Discussion board posts
- Assignment submissions and feedback
- Emails or messages related to the course
- Social media posts or interactions about the course
- Screenshots of relevant communications or interactions
- Any other materials that reflect your learning experience

Please rest assured that all materials will be handled with the utmost confidentiality, and any personal identifiers will be removed.

You can email these documents directly to me at nhv2as@virginia.edu.

If you have any questions or need further clarification, please do not hesitate to contact me. Your contributions are highly valued and will significantly enhance the depth of our study.

Thank you for your continued support and cooperation.

Best regards,

Soo Son
Doctoral Student
University of Virginia
School of Education and Human Development
nhv2as@virginia.edu

Appendix J – Document and Artifact Collection Protocol

Objective: To outline the procedure for the collection, management, and analysis of documents and artifacts related to the NOL MTH 161 Precalculus I course.

Scope: This protocol applies to all documents and artifacts collected from both instructors and students participating in the focus group discussions.

1. Collection of Documents and Artifacts
    a. Requesting Documents: Send a request email to instructors and students who participated in the focus groups, asking them to provide relevant documents and artifacts. Examples of documents include:
        - Course syllabi
        - Lesson plans
        - Discussion board posts and interactions
        - Assignment guidelines and rubrics
        - Feedback provided to students
        - Screenshots or records of communication (emails, LMS messages)
        - Social media posts or interactions related to the course
        - Notes or reflections on the course
        - Assignment submissions and feedback

    b. Submission Method: Participants can submit documents via email to the researcher.
    c. Confidentiality and Anonymity: Ensure that all collected documents and artifacts are handled with strict confidentiality. Remove any personal identifiers from the documents to maintain participant anonymity.

2. Inclusion and Exclusion Criteria
    a. Inclusion Criteria: Documents and artifacts must be directly related to the NOL MTH 161 Precalculus I course. Documents should be created by instructors or students participating in the focus group discussions. Artifacts should reflect the participants' experiences, feedback, and reflections on the course.

    Exclusion Criteria: Documents unrelated to the NOL MTH 161 course. Artifacts that do not provide meaningful insight into the teaching and learning experiences of the participants. Documents with personal identifiers that cannot be anonymized.

3. Management of Documents
    a. Storage: Store all collected documents and artifacts in a secure, password-protected Google Drive folder. Create subfolders to organize documents by participant type (instructors, students) and document type (syllabi, feedback, assignments, etc.).
    b. Labeling: Assign each document a unique identifier (e.g., DOC001, DOC002) and maintain a log in a separate document tracking sheet. Record the source ID (e.g., Instructor 1, Student 3) and type of document in the tracking sheet.

4. Analysis of Documents
    a. Initial Review: Conduct an initial review of all collected documents to identify relevant passages and content. Skim documents to highlight sections that directly relate to the research questions and focus group discussions.
    b. Thematic Analysis: Use a thematic analysis approach to examine the documents. Apply the codebook developed during the focus group analysis to code and categorize content. Identify themes and patterns that emerge from the documents, aligning them with the themes from focus group data.
    c. Triangulation: Use documents and artifacts to triangulate data from surveys and focus groups. Compare and contrast the findings from the documents with the verbal data to ensure consistency and validity.
    d. Reporting: Summarize the findings from the document analysis in the final report. Include relevant excerpts and examples from the documents to support the research conclusions.

5. Ethical Considerations
    a. Informed Consent: Ensure that all participants providing documents and artifacts have given informed consent. Clearly communicate the purpose of the document collection and how the data will be used.
    b. Data Security: Maintain strict data security protocols to protect the privacy and confidentiality of participants. Only the researcher will have access to the documents and artifacts.
    c. Retention and Disposal: Retain the documents and artifacts for the duration of the research project.
    d. Securely delete all files after the completion of the study, as per the data management plan.

Appendix K – Codebooks

This codebook outlines the codes that will be used to analyze qualitative data collected from open-ended questions and focus groups.

Category	Theme	Definitions
Course Presence	Structured Content	Refers to the organization, clarity, and coherence of course materials and activities. This includes well-organized modules, clear instructions, detailed schedules, and logical progression of topics to support student learning.
Course Presence	Resource Accessibility and Effectiveness	Encompasses the availability, usability, and impact of course resources, such as textbooks, videos, practice tools, or online platforms. This theme considers whether resources are easy to access and effectively support students in achieving learning objectives.
Course Presence	Assessment Design and Alignment	Focuses on the structure, clarity, and alignment of assessments with learning outcomes. This includes how well quizzes, homework, exams, and other evaluative tools measure the intended skills and knowledge, as well as whether they reflect course content and instructional goals.
Course Presence	Technical Barriers	Relates to challenges students face due to technology issues, such as difficulties with online platforms (e.g., ALEKS, Canvas), system glitches, poor integration between tools, or insufficient technical support. These barriers can disrupt the learning process and cause frustration.
Teaching Presence	Instructor Support	The availability, responsiveness, and actions of instructors in facilitating student learning. This includes real-time support, synchronous interactions, timely communication, and efforts to address students' questions or concerns effectively.
Teaching Presence	Adaptability and Personalization	The instructor's ability or limitations in tailoring course content, pacing, or teaching methods to meet individual student needs or preferences. This includes flexibility in addressing unique challenges, accommodating different learning styles, and overcoming structural constraints (e.g., fixed course design or policies).
Teaching Presence	Feedback	The quality, frequency, and usefulness of instructor-provided feedback on assignments, exams, and performance. Feedback should guide improvement, clarify expectations, and foster student understanding of course material and assessment criteria.
Teaching Presence	Policy Enforcement and Constraints	The impact of institutional or course policies on the instructor's ability to support students. This includes enforcing grading policies, late submission rules, academic integrity standards, and any structural limitations imposed by course design or institutional requirements.
Cognitive Presence	Problem Solving and Application	The ability to analyze, apply, and solve problems using learned concepts, reflecting critical thinking and adaptability.
Cognitive Presence	Confidence and Engagement	Students’ self-perception of their abilities and their level of active participation and persistence in the learning process.
Cognitive Presence	Cognitive Overload and Gaps	Challenges arising from excessive cognitive demands or unaddressed gaps in prior knowledge that impede new learning.

Social Presence	Peer Collaboration and Resource Sharing	Students working together to exchange knowledge, share resources, and support each other, fostering community and mutual learning.
Student Context	Varied Preparedness	Reflects varying levels of prior knowledge, skills, and readiness for course content among students, influenced by their academic background and prior experiences.
Student Context	Persistence and Barriers	Highlights challenges that impact students' ability to persist in the course, including personal responsibilities, workload, and external obstacles, as well as the strategies students use to overcome these barriers.
Student Context	Independent Learning Readiness	Focuses on students' ability to self-regulate, manage their learning in an asynchronous environment, and adapt to the expectations of online education.
Student Context	Time Management and Effort	Examines how students' ability to manage their time, balance responsibilities, and dedicate effort influences their performance and overall experience in the course.
Student Context	Assessment-Related Challenges	Captures specific struggles related to assessments, including test anxiety, frustration with proctoring tools, and the pressure to perform under time constraints.
External Resources	Tutoring Support	The availability and effectiveness of tutoring services, both on-campus and online, in addressing student questions, reinforcing concepts, and providing personalized assistance to enhance learning outcomes.
Evaluation Level	Level 1: Reaction	Students' immediate responses to the course, including their satisfaction, engagement, and perception of the overall learning experience.
Evaluation Level	Level 2: Learning	The knowledge and skills students acquire as a result of participating in the course, reflecting their understanding and retention of key concepts.
Evaluation Level	Level 3: Application	The extent to which students apply what they have learned in the course to solve problems, complete assignments, or perform tasks in other settings.
Evaluation Level	Level 4: Outcome	The long-term impact of the course on students' academic or professional progress, including readiness for subsequent courses or real-world application of skills.
Course Presence	Assessment-Related Challenges	Captures specific struggles related to assessments, including test anxiety, frustration with proctoring tools, and the pressure to perform under time constraints.
Course Presence	Tutoring Support	The availability and effectiveness of tutoring services, both on-campus and online, in addressing student questions, reinforcing concepts, and providing personalized assistance to enhance learning outcomes.
Course Presence	Level 1: Reaction	Students' immediate responses to the course, including their satisfaction, engagement, and perception of the overall learning experience.

Appendix L – Data Management Plan

The research project described in this data management plan (DMP) includes using qualitative student focus group interview data and individual student-generated document data from a Problem of Practice study situated in a suburban community college in Northern Virginia.

Data Types and Storage

For my study, I will use survey data and qualitative focus group interview data. The survey will be conducted during the Fall 2024 semester at NVCC Online. Survey data will be collected through Qualtrics. The semi-structured focus group will be conducted with instructors and students in NOL MTH 161. Focus group discussions will be recorded and transcribed. All data files will be uploaded to the secure personal Google Drive folder.

1. Data Organization and Documentation

The file naming convention will include the following:
StudentSurvey_Year.Month.Day_ResearcherInitials_Survey_final.docx
InstructorSurvey_Year.Month.Day_ResearcherInitials_Survey_final.docx
StudentFocusGroup_Year.Month.Day_ResearcherInitials_FocusGroup_final.docx
InstructorFocusGroup_Year.Month.Day_ResearcherInitials_ FocusGroup _final.docx
Data will be organized using a nested file system in the secure Google Drive. The system will be structured according to the following outline:

- Data Files
    - Survey
        - Student Survey
        - Instructor Survey
    - Focus Group
        - Focus Group Protocol
        - Focus Group Audio
        - Focus Group Transcriptions
    - Participant-Generated Documents and Artifacts

2. **Data Access and Intellectual Property**

   All data files will be uploaded to the secure personal Google Drive. To protect privacy and confidentiality, participants will be assigned pseudonyms before dissemination. Furthermore, all participants were assigned a source ID. Source IDs were recorded in a Google Doc separate from the surveys and semi-structured focus group interviews. This document will be uploaded to Google Drive. Personal data in the form of demographics and NOL student experience was collected from each participant. These data will be kept confidential through the use of pseudonyms and source IDs which are stored in a separate document.

3. **Data Sharing and Reuse**

   I do not intend for others to reuse my data nor intend to publish my data.

4. **Data Preservation and Archiving**

   The data will be preserved and archived in the secure personal Google Drive for 3-5 years. The file format used is .docx, which is long-lived.

Appendix M – NOL MTH 161 Course Syllabus

Course Syllabus

Please use the links below to jump to different sections on the same page.

Course Description | Course Objectives | Time Expectation | Course Requisite Technical Skills | Textbooks and Materials | Course Grading | Course Policies | Student Rights & Responsibilities | Overview of Assignments | Taking Proctored Assessments | Your Email Account | Student Resources | Accommodation Policy and Statements | [redacted] Online Policies and Procedures | Course Summary (Assignment Schedule and Critical Dates)

Course Title: MTH 161 - Precalculus I (3 credits)

Semester: INSTRUCTORS WILL TYPE INFO HERE

Faculty: **INSTRUCTORS WILL TYPE INFO HERE**

Print Syllabus: You may use the *Print* feature of your browser to print out the syllabus or save it as a PDF document.

Course Description

Presents topics in power, polynomial, rational, exponential, and logarithmic functions, and systems of equations and inequalities. Credit will not be awarded for both MTH 161 and MTH 167 or equivalent.

Prerequisite:

Students have either:

Completed through Algebra II in high school and have an overall high school GPA of 3.0 or higher.

OR

Completed the Virginia Placement Exam showing competency in MTE Units 1-9.

Course Objectives

Upon completing the course, the student will be able to:

Relations and Functions

- Distinguish between relations and functions.
- Evaluate functions both numerically and algebraically.
- Determine the domain and range of functions in general, including root and rational functions.
- Perform arithmetic operations on functions, including the composition of functions and the difference quotient.
- Identify and graph linear, absolute value, quadratic, cubic, and square root functions and their transformations.
- Identify and graph piece-wise defined functions.
- Determine and verify inverses of one-to-one functions.

Polynomial and Rational Functions

- Determine the general and standard forms of quadratic functions.
- Use formula and completing the square methods to determine the standard form of a quadratic function.
- Identify intercepts, vertex, and orientation of the parabola and use these to graph quadratic functions.
- Identify zeros (real-valued roots) and complex roots, and determine end behavior of higher order polynomials and graph the polynomial, and graph.
- Determine if a function demonstrates even or odd
- Use the Fundamental Theorem of Algebra, Rational Root test, and Linear Factorization Theorem to factor polynomials and determine the zeros over the complex numbers.
- Identify intercepts, end behavior, and asymptotes of rational functions, and graph.
- Solve polynomial and rational inequalities.
- Interpret the algebraic and graphical meaning of equality of functions (f(x) = g(x)) and inequality of functions (f(x) > g(x))

Exponential and Logarithmic Functions

- Identify and graph exponential and logarithmic functions and their transformations.
- Use properties of logarithms to simplify and expand logarithmic expressions.
- Convert between exponential and logarithmic forms and demonstrate an understanding of the relationship between the two forms.
- Solve exponential and logarithmic equations using one-to-one and inverse properties.
- Solve application problems involving exponential and logarithmic functions.

Systems of Equations

- Solve three variable linear systems of equations using the Gaussian elimination method.

Time Expectation

Research shows that students are most successful with distance education when they start their coursework on time and make steady progress. Refer to the chart to determine at least how many hours you should expect to spend on the assignments in the course according to the length of your section.

Weekly Study Time for Online Learning						
Course Length	**1 Credit**	**2 Credits**	**3 Credits**	**4 Credits**	**5 Credits**	**6 Credits**
6-week	5-8 hours/week	10-16 hours/week	16-24 hours/week	21-32 hours/week	26-40 hours/week	-
7-week	4-6 hours/week	8-12 hours/week	12-18 hours/week	16-24 hours/week	20-30 hours/week	-
8-week	4-6 hours/week	8-11 hours/week	11-16 hours/week	15-22 hours/week	18-28 hours/week	-
10-week	4-5 hours/week	7-10 hours/week	10-15 hours/week	13-20 hours/week	17-25 hours/week	-
12-week	3-4 hours/week	6-8 hours/week	8-12 hours/week	11-16 hours/week	14-20 hours/week	17-24 hours/week
15-week	2-3 hours/week	4-6 hours/week	6-9 hours/week	8-12 hours/week	10-15 hours/week	12-18 hours/week

To help you do this, please follow the due dates in the Course Summary (Assignment Schedule and Critical Dates) section below. **Submit one assignment at a time.**

Course Requisite Technical Skills

In order to succeed in this online course, you must be comfortable working with technology. At a minimum, you must possess the following technical skills:

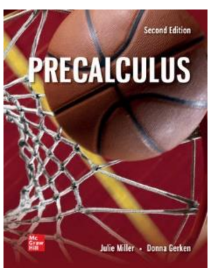
- Ability to use the Internet in an effective and efficient manner, including installation and management of browser plug-ins and add-ons.
- Basic knowledge about the operation of a computer, file management, and software installation.
- Working knowledge of the Canvas learning management system.
- Ability to proficiently search the web for information
- Ability to download and print information from websites
- Ability to download, view, and/or print PDF files

Textbooks and Materials

Required Textbooks

Access Code and Optional Text

The required material for this course are from McGraw Hill's ***PreCalculus***, 2nd edition, by Julie Miller and Donna Gerken



Only the ALEKS access code is required - **ISBN 8220130749668**.

***Note:** If you would like a loose leaf copy of the textbook in addition to the required ALEKS access code, use **ISBN 9781265383350**.

The **ALEKS** online class site is where you will find an online version of the text, video tutorials, practice problems, personal study guide, and your assigned homework and quizzes. You may start using the site as soon as it is opened; just create an account and get started. If your instructor has sent an announcement with an Financial Aid Access Code, you may follow the directions to use that code for up to 14 days. Please note that when you do buy the code, the amount of time purchased starts from the first time you accessed the course in ALEKS, not from when you bought the code. If the temporary code expires, your work will not be lost and you will be able to access everything once you purchase access. If you would like to purchase a hard copy of the textbook, a loose-leaf version is available for a nominal fee.

Calculator Policy

**Note - A scientific calculator IS permitted, but a graphing calculator is NOT permitted.

Acquiring Textbooks and Course Materials

Textbooks and Course Materials

The College has moved to a new student-centric course material delivery model in collaboration with Barnes & Noble. The program is called [redacted] All Access (formerly Barnes & Noble College First Day® Complete). [redacted] All Access will reduce the cost of course materials and ensure that you have all of your materials across all courses prior to the first day of class.

Instead of purchasing materials a[redacted]e on the [redacted] Online Bookstore Website, you receive access to all required course textbooks and digital materials for a flat fee per credit ($22.50/credit). You choose the delivery method that works for you (either pickup at the campus bookstore or direct shipment to your home) and receive all digital and electronic materials directly through Canvas. If the cost for course materials is determined to be less outside of NNNN All Access, you have the choice to opt out of the program each semester.

More information is available on the [redacted] Website (www[redacted]allaccess).

OER Courses

If your course uses Open Educational Resources (OER) or is “no materials required,” your instructor will let you know the best way to obtain your course materials in your syllabus. You **may not be required** to purchase textbooks and other materials for this course. We are making this information available so you can make an informed choice about participating in[redacted]’s new course materials program.[redacted] **All Access.** For more information on [redacted] **All Access**, please visit the website – www.[redacted]allaccess.

If your instructor indicates you are not required to purchase materials and you are taking only courses with no materials required, then you should opt out of the [redacted] All Access program.

Ebooks and Proctored Assessments

Electronic textbooks may not function during open-book assessments. Visit the Proctored Assessments Module or contact your instructor if you have any questions about the use of an ebook for open-book assessments in this class.

Notes for SSDL Students

SSDL students may purchase their textbooks from their campus bookstore or from the [redacted] Online Bookstore Website. However, **SSDL students using financial aid to pay for their books must purchase from their campus bookstore.** Be sure to check the [redacted] Online Bookstore Website for the ISBN number for the required textbook to ensure that you are buying the correct textbook from your campus bookstore. If you have any questions, please contact your home college liaison.

You may be required to access linked library resources for this course. When clicking on these links, you may be prompted to log in.

- To log in, use your VCCS username and password. This is the same username and password that you use to access your online course.
- For complete access to these materials, you also must be logged into your single sign-on page. This is the same page you use to access your Online Courses, Student Email, and VCCS Services. Please note, this page will time out with inactivity. You must be actively logged in to access the linked library materials in your course.

Course Grading:

The course grading criteria are listed below:

Assignments	Percentage of Grade
Syllabus Quiz and Discussions	5%
Homework	10%
Quizzes	15%
Proctored Assessments*: • Exam 1 • Exam 2	70%

• Exam 3 • Final *60% combined average required to pass the course	
Total	100%

Note that a grade of “D” is considered passing (see Academic Policies > Grades), but may not meet the prerequisites for some courses, such as calculus.

Please keep a personal record of all your grades so that you can compute your own course grade. **There is NO extra credit in this course!**

[redacted] Online proctored or major assessments are required to maintain compliance with our accreditation standards and the Higher Education Act’s identity verification requirements for online courses. College-wide, proctored or major assessments must prove identity. To accomplish this in online courses, students must show overall passing levels on the proctored or major assessments in order to pass the course.

In this online course, if your average score on all proctored or major assessments is a passing percentage of 60 percent or higher, then your grade will be calculated according to the scale in the table below. Otherwise, a final grade of F will be assigned.

Grading Scale

Your final grade will be based on the following scale. You must have an exam average of 60% and an overall average of 60% to pass the course with a D. Students must earn a "C" or better in this course to take the next course in sequence or to transfer the course.

Grade	Percent
A	90-100
B	80-89
C	70-79
D	60-69
F	0-59

Explanation of Assignments

- **Syllabus Quiz:** Taken in Canvas. Contains questions regarding the syllabus and rules of this course.
- **Discussions:** Posted in Canvas. Both initial post and replies to classmates.
- **Homework:** Completed in the Aleks program. There are assignments to be completed each week.
- **Quizzes:** Completed in the Aleks program.
  NOTE: You must install an **Aleks** Lockdown Browser (LB) from Aleks in order to take the quizzes.
  NOTE: Aleks LB does not use a camera for monitoring or provide an online calculator. You may use your own scientific calculator (not graphing).
- **Exams, including Final:** Completed in Canvas. There are two parts to each test. Part #1 contains the questions to answer on paper. Part #2 provides submission instructions for submission of copies of your work. There are no Exam retakes or extensions! If you have questions regarding the Exams, please contact your instructor beforehand.
  NOTE: You must install a Canvas Respondus Lockdown Browser in order to take these assessments.

Course Policies

Attendance Policy: INSTRUCTORS WILL TYPE INFO HERE

Late Work Policy: INSTRUCTORS WILL TYPE INFO HERE

Grading Turnaround Time:

All completed assignments will be graded no later than seven days after the due date, and sooner when possible.

Incomplete Policy:

The incomplete grade is used for verifiable unavoidable reasons. If you have made significant progress in your course, your end date is near, and you have reasons that can be documented as unavoidable, you may request a grade of Incomplete. To request a grade of Incomplete for this course, you must:

- Have satisfactorily completed 60 percent or more of the assignments (per VCCS policy)
- Explain your extenuating circumstances in writing
- Provide a plan for completing the remaining assignments in writing (all work must be completed by the end of the subsequent semester)
- The time you have to complete the course must be agreed upon with your instructor, but will be no more than one additional semester

Withdraw from the Course

For the specific course dates described below, refer to the **Quick Start Syllabus** mailed to you by [redacted] Online. For additional information, see [redacted] Online Academic Calendar.

1. Your Options for Withdrawing: (You must use my[redacted] to complete a withdrawal)
    - **Refund Date**: If you withdraw before this date, you will receive a refund and there will be no record of your enrollment.
    - **Last Withdrawal Date without F**:
        - If you withdraw after the refund date but before your **Last Withdrawal Date,** you will receive no refund and a grade of W.
        - If you withdraw after your last withdrawal date, you will receive no refund and a **grade of F.**
2. Instructor-Initiated Withdrawal
    - **Any One Assignment (NVRK) Due Date:**
      You must submit any one assignment before the date specified by your [redacted] Online Academic Calendar or you will be administratively deleted without a refund. Check the **Course Summary section of the Syllabus** for specific requirements. You will not be able to be added back to the class once you are deleted.

Student Rights & Responsibilities

Students should be familiar with the college's specific expectations concerning the conduct of its students. These expectations apply to all students (part-time or full-time) attending [redacted]. Student Rights and Responsibilities are outlined in the [redacted] Student Handbook (opens in a new window).

Academic Integrity

Academic integrity requires that you recognize and acknowledge information derived from others and take credit only for ideas and work that are yours. It should be the guiding principle for all that you do, from taking assessments and making presentations to writing papers. More about academic integrity at [redacted] can be reviewed on the Student Conduct and Integrity page on the [redacted] website.

Violating the Academic Integrity Policy will incur consequences. Your instructor may give you a failing grade for the assignment or for the course. Further, you may be reported for an academic integrity violation, reported to an academic dean, or even referred to the Dean of Students for disciplinary action depending on how serious an infraction was committed.

Overview of Assignments

Here is an overview of all of the different types of assignments in the course. You can find the detailed directions for the assignments and the grading rubrics in the module where they are assigned.

- **Syllabus Quiz:** Taken in Canvas. Contains questions regarding the syllabus and rules of this course.
- **Discussions:** Posted in Canvas. Both initial post and replies to classmates.
- **Homework:** Completed in the Aleks program. There are assignments to be completed each week.
- **Quizzes:** Completed in the Aleks program.
  NOTE: You must install an **Aleks** Lockdown Browser (LB) from Aleks in order to take the quizzes.
  NOTE: Aleks LB does not use a camera for monitoring or provide an online calculator. You may use your own scientific calculator (not graphing).
- **Exams, including Final:** Completed in Canvas. There are two parts to each test. Part #1 contains the questions to answer on paper. Part #2 provides submission instructions for submission of copies of your work. There are no Exam retakes or extensions! If you have questions regarding the Exams, please contact your instructor beforehand.
  NOTE: You must take each assessment using proctoring software.

Taking Proctored Assessments

[redacted] Student Code of Academic Integrity

As a [redacted] student, you should use academic integrity as the guiding principle for all that you do, from taking assessments and making presentations to writing papers. It requires that you recognize and acknowledge information derived from others and take credit only for ideas and work that are yours.

You violate this principle of academic integrity if you:

- Falsify and fabricate (e.g. your identity in an online course, the results of your research)
- Plagiarize
- Cheat

Since online courses and online requirements vary, your professor will help you understand what does and does not constitute cheating in your course and on your proctored assessments. Be sure to ask your professor if you aren't sure.

If you violate the Academic Integrity Policy, your professor may give you a failing grade for the assignment or for the course. Further, you may be reported for an academic integrity violation, reported to an academic dean, or even referred to the Dean of Students for disciplinary action depending on how serious an infraction was committed. Be sure to educate yourself about academic integrity at [redacted] by reviewing the Student Conduct and Integrity page on the [redacted] website.

Taking Proctored Assessments With Honorlock

Important: A webcam is required in order to take the Proctored Assessments in online courses at [redacted]. Please check the proctored assessment information in the Modules and review the college's minimum technology standards by pathway/school early on to be sure you will have everything you need in place to successfully complete your proctored assessments.

- Proctoring at testing centers is not currently an option.
- You will use Honorlock to take online assessments for this course at [redacted] Online.
- The Proctored Assessments module contains instructions for taking proctored assessments in this course and your professor will provide more detailed information.
- iPads are not an option for taking exams in Honorlock. If an iPad is your only mode of test-taking, please contact your professor.

- Please Note: You will need to work through the Proctored Assessments module to complete some required items before you will be able to complete the Proctored Assessments in this course. This includes an "Academic Integrity and Identity Verification" which requires Honorlock.

Downloading and Using Honorlock

You will not be asked for an access code when using Honorlock. If you are asked for an access code, you are possibly making one of the following errors:

- You are not using Chrome –exams must be opened in Chrome to use the Honorlock extension
- You have not downloaded the Honorlock extension or need to download it again – the extension can be downloaded from Honorlock
- You have an extension from another proctoring service on your computer – **remove any other proctoring extensions installed on Chrome browser**

If you continue having issues, please reach out to Honorlock support or [redacted] Online IT Support.

Directions for Using Honorlock

1. Before opening your proctored activity or assessment, ensure you are using Chrome browser.
2. **Uninstall any other proctoring extensions from your Chrome browser.** This can intefere with Honorlock which may prevent you from opening the assessment.
3. Follow the Honorlock Student Tutorial to view information on how Honorlock works.
4. Walk through the process you will complete when taking a proctored assessment using Honorlock.
5. Download the Honorlock Chrome extension. This extension works exclusively within Chrome and monitors the browser during the exam. Students can uninstall the extension after submitting their exam.
6. Make sure all extra tabs and browsers are closed. Honorlock will block students from proceeding with exams if any outside browsers or applications are open.
7. Open the proctored activity or assessment.

Honorlock offers 24/7/365 support. If students encounter any issues, they can reach out via live chat on the Honorlock support page.

Speak with your professor if you have any issues with taking a proctored assessment (such as privacy concerns, equipment problems, or inability to attend a synchronous assessment session). Professors are often able to work with you to meet your individual needs.

In addition to working with your professor, you may use the [redacted] Online proctor request process to create a special arrangement, such as taking an assessment at a nearby college testing center or military installation (for deployed students). Visit the student forms dashboard to fill out a request. Please note you must allow up to **5 business days** for staff to process a completed request. Delays in submitting your request and delays in response to the verification process with your proctor may result in missed assessments and grade penalties.

If you are enrolled in this course through a different Virginia Community College other than [redacted] (SSDL), you may contact your home college liaison for proctoring instructions about how to test at your home college.

Faculty will always work with students to implement their Office of Accommodations & Accessibility approved Memorandum of Accommodations (MOA), which may impact how your proctored assessments are given. Please reach out to your professor to discuss specific needs for the course and for course testing at the start of the semester to ensure you are fully supported.

Your Email Account

[redacted] Community College ([redacted] faculty, staff, and administrators communicate with students through their official [redacted] email accounts (_______@[redacted].edu) . Students are likewise required to use their [redacted] email accounts (________@email.vccs.edu) to communicate with instructors and other college personnel and should check their email accounts regularly. You are required to use this email account for any course-related email communication so that we can ensure your privacy as required by law. If you don't know your VCCS email address, go to My [redacted] and look for your address.

To log on to your email account and check for mail, go to the Email Login Page. Enter your complete email address as your user name. Use the same password as you use to log into VCCS systems (your date of birth in MMDDYY format, or your current password if you have changed it). If you need help, refer to the instructions on using student email.

Your email is how your instructor will inform you of grades; approaching due dates; or other private, course-related information. The instructor will also reply to your emails at your VCCS account and will not accept or respond to email sent by you from any account other than the one provided by the VCCS.

Student Resources

FREE Tutoring!

[redacted]'s Tutoring Centers offer **free** in-person and virtual tutoring to all [redacted] Nighthawks. To request an appointment for one-on-one tutoring, either in-person or via Zoom, log in to my[redacted] to select EAB Navigate.

In addition to in-person tutoring, 24/7 Tutoring is an online tutoring service that [redacted] Community College offers for free to **all** students. 24/7 Tutoring provides tutoring in a variety of subjects, many of which are available 24/7. To access 24/7 Tutoring, click on the **24/7 Tutoring** link located in your course on the navigation menu.

Frequently Used Student Software

Office 365: [redacted] students have access to Microsoft Office 365 ProPlus for free. It is available for both PC users and Mac users. Remember, Microsoft Office 365 is a subscription-based cloud service and is only free while a student. You can find more information about Microsoft Office 365 ProPlus on its website.

You can access Office 365 by going to: http://office.vccs.edu. Use your full VCCS student email address as your username (username@email.vccs.edu) , and your VCCS student password to log into the site. This is the password you use to login at My [redacted] for access to student email, Canvas, and [redacted]NConnect. Then follow Microsoft's directions to set up the software.

If you need assistance with the access to Microsoft Office 365, please check the Microsoft Website and contact Microsoft.

Google Apps: Your VCCS email is packaged with Google Apps, including Docs, Slides, Calendar, etc. You may check out the main features you have available to use by visiting the Google Apps for Education website.

Career Services

The College is committed to providing career services to all students as part of the comprehensive educational journey. Career Services assists students with exploring, developing and setting goals related to each student's unique educational and academic needs. These services include career assessments, occupational information, goal setting, planning and employment resources. You can request an appointment with a career counselor.

Office of Wellness and Mental Health

During your time at [redacted], you may experience challenges including struggles with academics, finances, or your personal well-being. [redacted] has support resources available. Please contact the Office of Wellness and Mental Health if you are seeking resources and support, or if you are worried about a friend or classmate.

Financial Stability and Advocacy Centers

The Financial Stability and Advocacy Centers provide assistance to students who are experiencing financial hardships that might prevent the students' academic success. The personnel at the Financial Stability and Advocacy Centers work with students to identify college or community services available. For more information, please visit the Financial Stability and Advocacy Centers webpage, or contact the office by calling [redacted] or emailing financialstability@[redacted].edu.

Emergency Preparedness

Information on what to do in case of an emergency can be found on [redacted]'s Office of Emergency Planning and Management (OEPM) website.

Accommodation Policy and Statements

[redacted] is committed to ensuring all students have an opportunity to pursue a college education regardless of the presence or absence of a disability. Information on [redacted]'s Accommodations and Accessibility Services, including how to reach an Accommodations and Accessibility Services counselor, can be found at Accommodations and Accessibility Services.

Under Section 504 and the Americans with Disabilities Act (ADA), disability services are available to currently enrolled students who have a documented disability that substantially limits them in one or more of life's major activities and who are otherwise academically qualified. Students requesting disability accommodations for a [redacted] Online course follow the same procedures as students requesting accommodations for a [redacted] campus-based course. Please carefully review the information on [redacted]'s Accommodations and Accessibility Services website. Students applying for accommodations for the first time will find instructions for completing and submitting the application on the Accommodations and Accessibility Services page.

Many of the activities in this course take place within the Canvas learning management system. You can learn more about the accessibility of Canvas here:

- Review the Canvas Voluntary Product Accessibility Template (VPAT) to evaluate Canvas' conformance with accessibility standards.
- See Accessibility within Canvas to check screen reader and browser combinations and keyboard shortcuts supported by Canvas.

The materials and activities are as accessible as possible with reasonable effort as outlined in the American with Disabilities Act Amendments Act (ADAAA) of 2008 and the Rehabilitation Act of 1973, Section 504.

[redacted] Online Policies and Procedures

Students are responsible for knowing and following the policies in the Student Handbook. The following are highlights of information that students should be aware of as they begin a course.

[redacted] Syllabus Insert

Emergency and Safety Information

Review [redacted]'s updated emergency and safety information.

Prerequisite Verification Statement

As noted in the Course Prerequisites Policy, some courses have prerequisite or corequisite requirements that are established to foster a student's success in the course. Students may not enroll in a course for which they do not meet the prerequisites by the time the course begins or for which they do not simultaneously enroll in any corequisite. Students may be administratively dropped from any course for which they have not met the prerequisite. If a course has a prerequisite, it is the responsibility of the student to ensure completion of this pre-requisite course first. Any student needing assistance in determining prerequisite or corequisite requirements can reach out to their faculty member or Campus Academic Division office for support.

Financial Aid

Students receiving financial aid are expected to attend and complete all classes. Withdrawing from a class can dramatically impact your financial aid status and may require repayment. To understand the impact of withdrawing from a course, please review pages 13-17 of the Financial Aid Handbook.

Time Zone

[redacted] Online assignment due dates are based on Eastern Time (ET).

Use these directions to change the Time Zone in your Canvas settings to stay on track with assignments.

Closing Information

[redacted] announces campus and college closings on the [redacted] homepage. You can also receive notification by cell phone or email if you register for [redacted] Alert. Also review [redacted]'s guidance on emergency closings, delayed openings, and continuation of instruction.

If a course is canceled due to a weather event or other unforeseen situation, check the course Canvas site or [redacted] email as soon as possible for instructions and assignments to avoid falling behind in coursework. You are expected to be up to date with all assignments the next time the class meets.

Course Drop/Withdrawal Policy

Please note these important deadlines related to your enrollment in a course:

- Students may drop courses through [redacted] Connect until the last day to drop with a tuition refund (census date). Students who drop a class during this period will receive a full refund.
- Requests to change your grade status to audit must also be completed before the last day to drop with a tuition refund (census date).
- Students who do not attend at least one class meeting or participate in an online learning class by the last day to drop with a tuition refund (census date) may be administratively deleted from the class. This means that there will be no record of the class or any letter grade on the student's transcript. The student's tuition will not be refunded.
- The *Last Day to Withdraw* is the last day to withdraw without a grade penalty. Students will receive a grade of W. Students may withdraw from a course through [redacted] Connect.

Dropping a course after the census date and before the withdrawal date will result in a "W" grade appearing on your transcript. To identify these dates for your courses, please visit the College Academic Calendar and scroll down to the specific session for your course. Please note that any drops or withdrawals from a course may impact financial aid, International Student status, or military benefits. Students with questions should check with the appropriate offices.

TITLE IX

Title IX is a civil rights law that prohibits discrimination on the basis of sex in educational programs, activities, admission, and employment. Complaints of sex-based discrimination including discrimination based on sex, gender, gender identity, sexual orientation, pregnant or parenting status, sexual assault, stalking, domestic violence, dating violence, and sexual or gender-based harassment are governed by the Title IX Policy. The Title IX Office also provides support measures for students and employees related to any form of sex discrimination, harassment, or sexual violence as well as accommodations for pregnant and parenting students. For information about Title IX or to make a report, please visit the Title IX web page.

[redacted] Website

The [redacted] Online Web Site will answer many general questions about [redacted] Online and the courses available through us. Please also read for the policies that govern your enrollment and the services available to you.

Call the [redacted] Online Hotline at [redacted] or [redacted] if you are unable to find the answers to your questions or if you need further information.

Course Summary:

Date	Details	Due
	Quiz Academic Integrity and Identity Verification (HONORLOCK)	
	Assignment ALEKS Homework	
	Assignment Any One Assignment Due/NVRK/Refund Date (Click for details)	
	Assignment Last Withdrawal Date Without F (Click for details)	

Date	Details	Due
	Assignment Module 1: Aleks: Quiz 1 (Sections 1.3-1.6)	
	Quiz Module 1: MTH 161 Exam 1 (5-23-A) (HONORLOCK)	
	Discussion Topic Module 1: Discussion - Exam 1 Review	
	Discussion Topic Module 1: Discussion - The Online Environment	
	Quiz Module 1: MTH 161 Exam 1 (5-23-A) - Submission	
	Assignment Module 2: Aleks: Quiz 2 (Sections 2.1-2.4)	
	Quiz Module 2: MTH 161 Exam 2 (5-23-A) (HONORLOCK)	
	Discussion Topic Module 2: Discussion - Exam 2 Review	
	Quiz Module 2: MTH 161 Exam 2 (5-23-A) - Submission	
	Assignment Module 3: Aleks: Quiz 3 (Sections 3.1-3.4)	
	Quiz Module 3: MTH 161 Exam 3 (5-23-A) (HONORLOCK)	
	Discussion Topic Module 3: Discussion - Exam 3 Review	
	Quiz Module 3: MTH 161 Exam 3 (5-23-A) - Submission	
	Quiz Module 4: MTH 161 Final Exam (5-23-A) (HONORLOCK)	
	Discussion Topic Module 4: Discussion - Final Exam Review	
	Quiz Module 4: MTH 161 Final Exam (5-23-A) - Submission	
	Quiz Required Practice Submitting PDF Quiz	

Date	Details	Due
	Quiz Welcome: MTH 161 Syllabus Quiz	
	Discussion Topic Welcome: Discussion - Introductions	