A Case Study of a College Algebra Co-Requisite Pilot: Exploring Student Perceptions

Natalia P. Darling
University of Cincinnati

Sarah Ferguson
University of Cincinnati

Alex Kemphaus
University of Cincinnati

The purpose of this case study research project was to examine student perceptions of a redesigned College Algebra co-requisite pilot course at a Mid-Western University. A group comprised of mathematics teachers from two of the University's regional colleges developed a co-requisite College Algebra design to develop student content and study skills and address concerns for student success and retention goals. This paper describes students' perceptions and how the co-requisite design impacted student outcomes. This case study focused on three research questions: 1) What are student perceptions of a co-requisite and College Algebra experience? 2) How are students' perceptions and participation in open access co-requisite College Algebra supplementary review sessions relevant to their mathematics learning, persistence, and achievement? 3) How do teachers perceive effectiveness of co-requisite support activities and student engagement and persistence? To investigate these questions, for fall 2023 and spring 2024 semesters, student participants enrolled in the pilot co-requisite College Algebra and CO-REQ supplementary review sessions provided feedback via surveys and their teachers submitted reflective observations. Themes that emerged from the qualitative analysis relate to student characteristics, co-requisite design aspects that are viewed as beneficial, barriers related to format and equitable access, and outcomes that indicate the supplemental course was helpful for students.

Nationally, over 59% of incoming students at two-year colleges are placed at a remedial course work mathematics sequence (Chen et al., 2016). The pandemic has only heightened concerns on student learning slide and a

potential "COVID crash" (Mangan, 2021) that may create more obstacles for student preparedness for college. To address college readiness concerns, multiple studies have applied a co-requisite mathematics model as an alternative pathway to developmental education (Andrews & Tolman, 2021) as an approach to issues with low retention rates and low graduation rates associated with developmental remediation at two-year colleges (Logue et al., 2019). Existing studies tend to emphasize quantitative aspects of predictors of success, focus on academic success and completion, and emphasize *non*-STEM (Science, Technology, Engineering, and Mathematics) based courses such as quantitative literacy and statistics (Andrews & Tolman, 2021; Boatman, 2021; Clinkenbeard, 2021; Logue et al., 2019). There is a paucity of studies that explore qualitative student perceptions regarding STEM-based College Algebra co-requisite courses. There are few studies that focus on students enrolled in Mid-Western STEM-based open-access College Algebra co-requisite courses.

This qualitative case study adds to existing research by exploring student perceptions of STEM College Algebra co-requisite experiences at Mid-Western regional colleges, and how students' engagement in these courses are relevant to student persistence and achievement. This project uses Vygotsky's (1978) Socio-Cultural Theory as a mathematical pedagogical approach to scaffold student learning and focus on learners as active participants. Astin's (2012) Input-Environment-Outcome model is used as a theoretical framework to analyze perceptions of co-requisite teaching and learning approaches and context (Andrews & Tolman, 2021) and to consider learner input, teaching environment, and learner outcomes. To investigate College Algebra co-requisite experiences from students' perspectives and understand factors that address student motivation and success, three main research questions were explored:

1) What are student perceptions of a co-requisite and College Algebra experience?
2) How are students' perceptions and participation in open-access co-requisite College Algebra supplementary review sessions relevant to their mathematics learning persistence, and achievement? and
3) How do teachers perceive effectiveness of co-requisite support activities and student engagement and persistence?

The research questions and small class sizes led to choosing a qualitative case study design. The research design sought to humanize the co-requisite experience and give voice to students pursuing educational achievement. Students enrolled in either fall 2023 or spring 2024 semester open access redesigned co-requisite College Algebra and supplementary review sessions were given the opportunity to participate in this study. As part of normal class requirements during the semester, all students completed reflective assignments on study skills, critical thinking skills, and topics relevant for College Algebra skills. Their feedback was captured via pre-and-post surveys that each consisted of eleven questions on their mathematics content preparation and learning process. Survey questions captured details on demographics, Likert-based 5-point scale questions on mathematics identity and course perceptions, and open-ended questions on insights of course environment.

This paper discusses a summary of the literature on existing co-requisite mathematics studies and the study's choice of theoretical framework, design methodology applied for data collection instruments and plan, researchers' positionality statements, data analysis implementation plan, and an overview of findings. A discussion of the study outcomes and recommendations for future studies on STEM-based College Algebra co-requisite is provided.

Literature Review

This research study is set in two open-admission, open-access regional colleges of a Mid-Western university. Regional colleges are two-year colleges that are part of four-year colleges and offer low-cost options, smaller classes, and individualized resources to develop skills to "participate meaningfully in local communities" (Kisker, et al., 2016, p. 316). Open-admission and open-access regional colleges have nonselective admission policies and embrace access to democratic participation by enabling every applicant who has completed high school or a GED to access higher education opportunities and focus on ensuring preparation of underprepared students to enable this access (Scherer & Anson, 2014). Two-year community colleges historically serve underserved and underrepresented groups and provide an option to pursue university and career opportunities (Kisker et al., 2016). Typically, two-year college student representation includes students who are first-generation college attendees, from lower socio-economic status communities, and diverse linguistic, racial, ethnic, and cultural communities. Regional colleges have

the role of meeting the needs of diverse students and addressing college preparedness.

Unfortunately, traditional approaches to provide student support include remedial mathematics course sequence which are meant to bridge gaps and target increased student success but fail to address retention and completion (Childers et al., 2021; Douglas et al., 2023). Support required from administration and instructors is exacerbated by the effect of post pandemic on first-year college students' preparation for mathematics (Schwartz, 2023). Existing research explores alternate remediation and pathways for students that require developmental math sequence and the effects on student success and completion (Childers et al., 2021; Ragsdale et al., 2021). Alternate pathways include summer bridge course work, compressed remediation, and co-requisite mathematics that provide support during college-level course work as a substitute for remedial mathematics course sequence (Logue et al., 2019).

Student College Readiness Support: Co-Requisite Mathematics

Research findings on redesigned course "just in time" supplemental workshops and sessions indicate improvements for student completion and success for students in mathematics courses that apply accelerated delivery or co-requisite design (Boatman, 2021). Richardson and Dorsey (2019) explain co-requisite design considerations and provide recommendations for design. Andrews and Tolman (2021) study on co-requisite mathematics review existing research studies from Louisiana, California, and Tennessee and explain that co-requisite mathematics model set as a pass/fail course paired with college-level required math classes serves as an effective alternative pathway compared to traditional developmental education. Their research also points out studies' limitations and lack of details on how to develop academic interventions and lack of focus on STEM course work (research findings focus on non-STEM mathematics courses such as quantitative literacy and statistics as courses that align with students' major/career interests).

Logue et al. (2019, p. 300) reminds educators and administrators that "a demonstrated knowledge of the remedial course material was not particularly beneficial to students' subsequent college success," and their research analyzes quantitative literacy and statistic courses. Clinkenbeard's (2021) research on quantitative literacy co-requisite considers equity as an aspect of co-requisite courses that avoid deficit mindsets on student shortcomings. Co-requisite mingling with for-credit college mathematics

provides metacognitive motivation. An equitable asset-based constructivist epistemology that focuses on student active participation led to choosing Vygotsky's (1978) Socio-Cultural Theory (SCT) and Astin's (2012) Input-Environment-Outcomes (IEO) theoretical framework for this study.

Theoretical Framework: Vygotsky's SCT and Astin's IEO

This project's College Algebra course design applied Vygotsky's SCT and Zone of Proximal Development for mathematical pedagogical approach to scaffold student learning. Student interaction and class collaborative activities were central to mathematical meaning-making. Teachers scaffolded the supplemental review sessions but emphasized student construction of knowledge. Student background knowledge and cultural tools for learning align with Astin's IEO theoretical framework that considers participant background, characteristics, and interests as an input aspect to learning, the college learning environment factors that influence student learning, and outcomes of this teaching and learning environment (Andrew & Tolman, 2021).

Methodology

This study's research purpose focuses on concerns for student motivation and persistence in STEM-based mathematics College Algebra courses. This study applies a qualitative case study approach to explore student perceptions of a College Algebra co-requisite redesign pilot course at two regional campuses in a Mid-Western university setting. The three research questions focus on 1) What are student perceptions of their experiences in the College Algebra co-requisite pilot; 2) How are students' perceptions and participation in open-access co-requisite College Algebra supplementary review sessions relevant to their mathematics learning, persistence, and achievement; and 3) How do teachers perceive effectiveness of co-requisite support activities and student engagement and persistence? Yin (2009) states a case study's research questions pose the "'who,' 'what,' 'where,' 'how,' and 'why' questions" (p. 9) and are a research approach that has two elements: an investigation of real-world phenomenon, and a clear context and boundary (p. 15). The researcher's choice of a case study is based on investigating student perceptions of experiences in co-requisite STEM-based College Algebra which is a current approach to improve student retention and success in mathematics. Why this matters is this focuses on student success and persistence in an open-access Mid-Western college environment which caters to underrepresented

and underserved students who overrepresent first-generation and low-income status. This study's research questions pose the *what* and *how* question forms to explore student perceptions and understand outcomes to add to current co-requisite research conversations.

Although initial research investigator intentions were to use a mixed-method approach, the small number of students in College Algebra co-requisite classes consisting of a maximum of 25 students per class for a total of three instructors resulted in supplemental review sessions that comprised of three to six students per semester for a total of three supplemental classes at both regional colleges. A qualitative research approach is appropriate for this study that explores student persistence, motivation, and success with a co-requisite STEM-based College Algebra intervention to understand student experiences, insights, and perspectives and interpret implications of findings (Creswell & Guetterman, 2019).

Participants and Setting

This project involved a group of five mathematics professors from two Mid-Western university regional sites. Three members of the group identify as White, one as Middle Eastern, and one as Latina; two are male professors and three are female professors. For the first year of the two-year project, the group had meetings that included department chairs and STEM professors who shared active-learning teaching approaches and experiences with co-requisite mathematics. During the second year, annual year 2023-2024, the co-requisite pilot was completed by three of the five mathematics professors in the group, and the remaining two served as co-principal investigators. One diverse suburban regional site, College A, has student ethnicity representation of 64% White, 26% underrepresented minorities (Black or African American, Hispanic or Latino, and two or more races), 5% Asian, 2% unknown race/ethnicity, and 2% non-resident alien (US News, 2024). The other rural regional site, College B, has student ethnicity distribution of 74% White, 15% underrepresented minorities, 3% Asian, 6% unknown race/ethnicity, and 2% non-resident alien (US News, 2024).

The university Institutional Review Board granted approval for this research study to be conducted at both regional sites during fall 2023 and spring 2024. Only students enrolled in the redesigned co-requisite College Algebra classes and its optional supplementary research sessions (SRS, CO-REQ) at either of the two regional sites were invited to participate in the study. Students who enrolled in the three-credit co-requisite redesigned College Algebra course had the option to take an optional one-credit CO-

REQ class. The co-requisite College Algebra professors encouraged students who were struggling during the first two weeks to enroll in the CO-REQ class, and two of the three mathematics professors had students enroll in the co-requisite CO-REQ classes. One professor taught College Algebra in a hybrid format, and the CO-REQ was taught as a face-to-face in person class; and the other professor taught both College Algebra and the CO-REQ in Hyflex format.

The authors/researchers of this paper, including two co-principal investigators from the group, were engaged in the recruitment process, and adhered to IRB guidelines. The co-requisite course professors included an invitation to the research study in their course Learning Management System. To prevent any conflict of interest, the authors/researchers administered consent forms to students when the course professors were not present. Student participants include a total of eleven students, pseudonyms are shown in Tables 1 and 2, enrolled in both co-requisite CO-REQ and redesigned pilot College Algebra classes for fall 2023 and spring 2024, and a total of eleven students enrolled only in the co-requisite redesigned pilot College Algebra classes for fall 2023 and spring 2024 semesters. Student participants are listed in the attached table (see Table 1 and Table 2). All participant names listed are pseudonyms, to adhere to IRB confidentiality.

Table 1: *Co-requisite College Algebra and CO-REQ Participants*

Semester	**Participant**	**College Algebra Course Format**	**CO-REQ Format**	**Demographic Identity**	**Open-Access Mid-Western Regional College**
Fall 2023	Camila	Hybrid	In-person CO-REQ	White Female	College A
	Aria	Hybrid	In-person CO-REQ	Black/African American Female	College A
	Henri	Hybrid	In-person CO-REQ	White Male	College A
	Luna	Hybrid	In-person CO-REQ	Hispanic Female	College A
	Joe	Hybrid	In-person CO-REQ	Unknown	College A
	Amy	Hyflex	Hyflex CO-REQ	White Female	College B

			(attended all online)		
	Rory	Hyflex	Hyflex CO-REQ (attended mostly in-person)	Unknown	College B
	Rachel	Hyflex	Hyflex CO-REQ (attended half online, half-in-person)	White Female	College B
	Brian	Hyflex	Hyflex CO-REQ	White Male	College B
Spring 2024	Elijah	Hybrid	In-person CO-REQ	African American Male	College A
	Jacob	Hybrid	In-person CO-REQ	White Male	College A

Table 2: *Participants enrolled only in Co-requisite College Algebra*

Semester	**Participant**	**College Algebra Course Format**	**CO-REQ Format**	**Demographic Identity**	**Open-Access Mid-Western Regional College**
Fall 2023	Teri	Hybrid	Not enrolled	Unknown	College A
	Hadaya	Hybrid	Not enrolled	Unknown	College A
	Fran	Hybrid	Not enrolled	Unknown	College A
	Sol	Hybrid	Not enrolled	Unknown	College A
	Jin	Hybrid	Not enrolled	Unknown	College A
Spring 2024	Destiny	Hybrid	Not enrolled	White Female	College A

	Ethan	Hybrid	Not enrolled	White Male	College A
	Liam	Hybrid	Not enrolled	White Male	College A
	Genet	Hybrid	Not enrolled	Unknown	College A
	Guozhi	Hybrid	Not enrolled	Asian Male	College A
	Nina	Hybrid	Not enrolled	Multi-racial Female	College A

Data Collection Procedures and Instruments

To explore student perceptions of experiences in the CO-REQ and College Algebra courses, data artifacts included student pre-and-post surveys and teacher reflections of student engagement with topics that address content and study skills. In addition to surveys that professors administered as part of normal course work, student participants were given the option to participate in optional focus group interview sessions which could be done online or in-person.

The pre-and-post-surveys (see Attachment A) administered to students consisted of ten to eleven questions. The pre-survey contained demographics questions, and six Likert-scaled (five-point scale) questions focusing on mathematics identity, and perceptions of experiences in the math course. College Algebra students were also asked if they registered for the CO-REQ and the reason for enrolling or not enrolling in that class. The post-survey contained the same six Likert-scaled questions and five open-ended questions focusing on aspects of the co-requisite and College Algebra course that were helpful or could be improved.

Not all students submitted both a pre-and-post survey, and since the surveys administered in College B had a variation of the IRB-approved Likert-scaled questions, these Likert responses could not be included for data analysis. A total of four pre-and-post submissions collected were valid for analysis of Likert-scaled responses. A total of seven pre-survey open-ended responses had student submissions for the question “Did you register for supplemental corequisite MATH1096, if yes state why you chose to do so, and if no state why you did not choose to participate in that course?” (two enrolled in both College Algebra and CO-REQ, and five in only College Algebra). A total of 16 post-survey open-ended responses were submitted

by students (nine students enrolled in both College Algebra and CO-REQ, and seven enrolled only in College Algebra). No students engaged in interview sessions (see Attachment B).

The two mathematics professors for College Algebra and CO-REQ courses, from the two regional sites, completed reflective responses to pre-defined prompts (see Attachment C). Each professor provided at least two reflections that addressed the start of the semester and later in the semester. Only one professor assigned to the pilot College Algebra and CO-REQ course submitted reflections for the spring 2024 semester. The second professor from College B taught the courses but did not have any student consent for spring semester to participate in the research study.

Data Analysis Process

Data analysis was conducted by the three authors, who also served as researchers. The participant responses to open-ended pre-and-post survey prompts were reviewed separately by each of the researchers to ensure internal validity of qualitative analysis. The three researchers applied triangulation of the data sources by comparing student pre-survey, student post-survey, and professor reflections that spanned the semester. Two of the three researchers were part of the original group and referred to prior meetings and emails related to the study. The third researcher joined the team post data collection.

All three researchers analyzed qualitative data according to Austin's Input, Environment, Outcomes Apriori themes. Each researcher reviewed the pre-survey and post-survey participant responses and noted Input, Environment, and Outcome descriptive codes. Miles et al. (2020) describes descriptive codes as short phrase labels that capture the essence of a particular passage and are well aligned to non-interview setting. In Vivo coding was also used to honor the voice of participants to ensure themes are portrayed that exhibit participant voice and views. All three researchers then collectively reviewed themes to triangulate findings.

In addition to qualitative data analyses, a basic mean and median calculation was used to explore participant responses to the six posed Likert scale questions. Both the pre- and post-survey used slight variations of the same six Likert scale questions. The pre-survey questions were worded to note participant responses before completing their semester coursework. The post-survey questions had tense changes to refer note participant responses after completing their semester coursework (See Attachment D). The questions addressed student confidence with their mathematics skills.

Teacher reflections are analyzed based on Vygotsky's (1978) SCT teaching framework for student group work, discussion, and instructor scaffolding.

Results: Themes

Analysis of the student and professor data artifacts resulted in themes related to students' perceptions of their CO-REQ experiences. Results will be presented in alignment with the research questions. Five themes emerged for the first research question, two themes emerged for the second research question, and two teacher perspectives are relevant for the third research question.

Themes for Research Question 1

The first research question stated: What are student perceptions of a co-requisite and College Algebra experience? Descriptive statistics relevant to student responses for the Likert-scaled questions are discussed first, and then data analysis outcomes related to qualitative open response questions are provided. Four students from the CO-REQ course completed both the pre- and post-survey. For each of these survey questions, the mean value increased from the pre-survey to the post-survey, indicating improved comfort level and confidence in their mathematics abilities (see Table 3).

Table 3: *Pre- and Post-Survey Likert responses*

	Q1		Q2		Q3		Q4		Q5		Q6	
Student	Pre-Survey	Post-Survey	Pre-Survey	Post-Survey	Pre-Survey	Post-Survey	Pre-Survey	Post-Survey	Pre-Survey	Post-Survey	Pre-Survey	Post-Survey
Mean	2.75	3.25	3.5	4	2.75	3.75	4.25	4.5	3.25	3.5	3.25	4
Median	3	3	3	4	2.5	3.5	4	4.5	3	3	3.5	4

For qualitative analysis of students' responses to open-ended questions, we applied Astin's I-E-O framework, and five themes emerged relevant to input and environment details. The five themes include 1) Integrity and initiative; 2) Homework is helpful; 3) CO-REQ peer problem solving is beneficial; 4) CO-REQ students value opportunities to receive help and ask questions; 5) Concerns with Hybrid/Hyflex format.

One theme that emerged relative to Astin's input characteristics is student integrity and initiative. Limited information was shared by students pertaining to input details such as student backgrounds, but student comments show that students had a willingness to take initiative and

expressed a dedication to wanting to be successful in their course experience. All students from the CO-REQ revealed initiative and discussed extra class time and dedication to study and practice. Students who were only in the College Algebra course were also dedicated to class preparation, and their comments focused on external resources and preparation. The next four themes are pertinent to Astin's environment aspects.

Both CO-REQ and College Algebra students found homework helpful. Nina, Rory, Sol, Fran, Hadaya, and Luna commented that the homework was the most helpful aspect of their course experience. This shows these students valued the assigned homework questions as time to work on and refine their computational skills. Hadaya, and Fran from the College Algebra section stated they needed to dedicate extra time to search for external resources to review for homework.

CO-REQ peer problem solving is beneficial to students, and Aria commented "having my peers help me," as an important aspect of the supplemental sessions. Elijah wrote that "it is helpful to get input on how to get the problem solved from your peers." The CO-REQ teachers implemented an environment to scaffold student questions and emphasized student peer-to-peer interaction as active participants, and students who registered for the course worked well in this setting.

CO-REQ students value opportunities to receive help and ask questions from their professor during their extra session time. Elijah explained that "everything was broken down so you could understand," and Jacob said the interaction "really helps polish your skills." This shows students taking advantage of this scaffolding teaching and learning opportunity.

College Algebra students expressed concerns with Hybrid/Hyflex format. Genet, Nina, and Hadaya felt class time was insufficient, and Teri said, "it was difficult to do the assignment alone + stay up to date on information," and as a result she "did not get as much out of the course."

Themes for Research Question 2

The second research question stated: How are students' perceptions and participation in open-access co-requisite College Algebra supplementary review sessions relevant to their mathematics learning persistence, and achievement? Descriptive statistics relevant to student letter grades are discussed first, and then data analysis outcomes related to qualitative open response questions are provided.

For the fall 2023 semester, all students in the CO-REQ courses passed the course. One student in the Spring 2024 CO-REQ course did not pass, but the instructor commented that this student ceased coming and participating in the course early in the semester. For the nine CO-REQ student respondents who passed the supplemental one-credit course, data on two letter grades was not provided by the instructor for the College Algebra grades, but of the remaining 7 respondents, all passed College Algebra with a C- or higher (4 As, 1 B, 2 C letter grade range). For the student respondents who were only in College Algebra, one student withdrew from, and two students did not pass the College Algebra course. Grade details for the CO-REQ and College Algebra courses are shown in Table 4.

Table 4: *Course Grades*

Course Grades			
Semester	Course	Grade	Tally
Fall 2023	Math 1096 CO-REQ	Pass	7
		Not Pass	0
	Math 1021 College Algebra	A	2
		A-	2
		B	2
		B-	2
		C+	1
		C-	1
Spring 2024	Math 1096 CO-REQ	Pass	2
		Not Pass	1
	Math 1021 College Algebra	A	2
		A-	1
		B	1
		C	1
		C-	1
		W	1
		NP	2

Analysis of student responses to open-ended questions resulted in two themes based on Astin's outcomes for I-E-O framework: 1) CO-REQ respondents recommend this course; 2) College Algebra respondents who wished to take CO-REQ had scheduling conflicts.

As an outcome measure, when asked if they would recommend the CO-REQ course to other students, CO-REQ students unanimously commented yes, they would recommend the course. Camila commented "Yes. It is good to have a course made to help you better understand things." According to Henry, "this course is a key component to success with math." Amy and Rachel both commented that the course is helpful. All 9 CO-REQ respondents commented that the CO-REQ course was helpful, and all passed the CO-REQ course. Additional comments from participants emphasize the outcome themes expressed. Luna commented that they wished they could have taken the CO-REQ and College Algebra courses as a full in person course, instead of as an online course. Nina expressed dissatisfaction that there were "no in person lesson, just review" in the College Algebra course, and Camila commented, "It is good to have a course made to help you better understand things."

Interestingly, even though instructors and researchers addressed the class multiple times and information regarding the CO-REQ was announced and shared via the course LMS, one student (Guozhi)

commented they were not aware of the CO-REQ course. Two students wished they had extra help, and three students commented they were not able to take advantage of the CO-REQ course due to work conflicts or time conflicts. These conflicts speak to equity concerns regarding the CO-REQ separate schedule for students who have work and/or family constraints.

Themes for Research Question 3

The third research question asked: How do teachers perceive effectiveness of co-requisite support activities and student engagement and persistence? Instructors were asked to complete a reflection to share their insights relative to the CO-REQ course. One instructor commented that the students who self-enrolled in the CO-REQ course were high-performing students who "have strong math backgrounds and striving for an A in College Algebra. The expectation was that students would require support on math skills, but this group was high-performing and requested additional homework review." This instructor went on to comment that the small group size "resulted in a deeper personal relationship" with the students. The second instructor commented that strong student peer-to-peer collaboration for group activities and review were a strength of the CO-REQ model. Their CO-REQ content focused on College Algebra topics including linear inequalities, exponentials, and logarithms. Interactive activities, which required pair and group discussions, began with instructor guidance and questions, and developed into student peer-to-peer engagement and support were commonly used to review CO-REQ topics. These interactive activities promoted high levels of engagement, leaving students to request instructor assistance only when they feel "stuck."

Attendance was listed as a concern by both instructors. One instructor found that at one point only 2 of 6 students were attending the CO-REQ course. The two students in attendance were engaged and worked well. Both instructors also commented that the CO-REQ course did not play out the way initially intended. Prior to launching the CO-REQ course, instructors and researchers spent time developing activities to parallel the College Algebra curriculum and provide scaffolding support for struggling students. These resources were not implemented as in actuality the CO-REQ students were strong students who did not need additional support. One instructor commented that study skills, self-confidence in their mathematics ability, and time management skills were more of a conversation focus in the CO-REQ course.

Limitations and Implications for Future Direction

The CO-REQ course proved valuable to students but did not turn out as intended at the onset of this pilot project. Low enrollment was based on a small student enrollment number for each College Algebra class and student schedules not being able to mesh with an additional course time requirement. Signing up for CO-REQ as a separate course after the semester began did not prove to be a sustainable model. Students who did enroll in the CO-REQ course appreciated the instructors' taking time to cater CO-REQ sessions to student needs while promoting peer collaboration and providing resources, such as homework, to practice and hone skills.

Future studies are recommended as the need to explore ways to promote success in College Algebra continues to be a valuable topic. The research group from this study is next going to focus on offering a 4 credit College Algebra course that combines the CO-REQ and College Algebra experiences from this study into one course. With the additional time of a 4-credit course, the strengths of the CO-REQ course, such as focused time to work on problem-solving, teacher support, and peer collaboration, will be blended continuously into the College Algebra course experience.

Initially, this study was designed to have additional data collection measures through focus groups and interviews conducted with CO-REQ and College Algebra students. Disappointingly, no student participants responded as willing to participate in interviews or focus groups to further discuss their experiences. This lack of additional student voice data and the small sample size of this study are limiting factors.

The CO-REQ course proved valuable to students. Student perceptions of the co-requisite and College Algebra experience was the CO-REQ was valuable and provided good opportunities to engage with peers and instructors. Student participation in the CO-REQ courses was strong and grades reflected solid understanding of the College Algebra content. While the CO-REQ courses did not go as initially visualized, instructors found the time with students to be valuable and saw good participation and engagement amongst students.

Discussion

In summary, two-year open-access colleges continue to address the importance of students' preparation for college-level mathematics. This qualitative case study focuses on open-access College Algebra co-requisite courses at two Mid-Western regional colleges. Our purpose was to explore

both student and teacher perceptions to consider student motivation, persistence, and achievement. The data collected and analyzed helped explore student perceptions of their experiences in the pilot CO-REQ learning environment, how their perceptions and participation are relevant to their math learning and achievement, and how teachers perceive the effectiveness of CO-REQ learning activities. Descriptive statistics reveal CO-REQ participants indicate an improved confidence in their math learning abilities, and, for this small number of students, the grade details are encouraging. Qualitative analysis outcomes indicate students in the CO-REQ section valued extra time to review questions, peer-problem-solving time, and recommend this course. Both CO-REQ and College Algebra students who were not enrolled in CO-REQ demonstrated dedication and integrity, and College Algebra participants concurred with CO-REQ peers that homework was helpful, but expressed concerns related to insufficient class time. This concern, combined with College Algebra student issues regarding CO-REQ separate schedule time constraints impacted the decision for future courses. College Algebra and CO-REQ will be offered as a 4-credit course to address equity access and scheduling concerns, while still promoting opportunities for deeper personal instructor-student and peer interactive classroom engagement. The findings are valuable for teaching-centered two-year college decisions on CO-REQ college algebra implementation to support students.

References

Andrews, D., & Tolman, S. (2021). *Predictors of student academic success in the corequisite model*. Georgia Journal of College Student Affairs, 37(2), 20. https://doi.org/10.20429/gcpa.2021.370203

Astin, A. W. (2012). *Assessment for excellence: The philosophy and practice of assessment and evaluation in higher education*. Rowman & Littlefield Publishers.

Boatman, A. (2021). Accelerating College Remediation: Examining the Effects of Math Course Redesign on Student Academic Success. *The Journal of Higher Education (Columbus), 92*(6), 927-60. https://10.1080/00221546.2021.1888675

Chen, X. (2016). Remedial Coursetaking at US Public 2-and 4-Year Institutions: Scope, Experiences, and Outcomes. Statistical Analysis Report. NCES 2016-405. *National Center for Education Statistics*. https://go.exlibris.link/lYStwBrL

Childers, A. B., Lu, L., Hairston, J., & Squires, T. (2021). Impact and Effects of Co-Requisite Mathematics Remediation. *PRIMUS: Problems, Resources, and Issues in Mathematics Undergraduate Studies, 31*(2), 167-183. https://10.1080/10511970.2019.1639865

Clinkenbeard, J. E. (2021). Course design and academic outcomes in quantitative literacy after eliminating required remediation. *Numeracy: Advancing Education in Quantitative Literacy, 14*(1), 1-22. https://10.5038/1936-4660.14.1.1373

Creswell, J. W., & Guetterman, T. C. (2019). *Educational Research: Planning, Conducting, and Evaluating Quantitative and Qualitative Research, 6th Edition*. Pearson.

Douglas, D., Logue, A. W., & Watanabe-Rose, M. (2023). The Long-Term Impacts of Corequisite Mathematics Remediation with Statistics: Degree Completion and Wage Outcomes. *Educational Researcher, 52*(1), 7-15. https://10.3102/0013189X221138848

Kisker, C. B., Weintraub, D. S., & Newell, M. A. (2016). The Community Colleges' Role in Developing Students' Civic Outcomes: Results of a National Pilot. *Community College Review, 44*(4), 315-336. https://10.1177/0091552116662117

Logue, A. W., Douglas, D., & Watanabe-Rose, M. (2019). Corequisite Mathematics Remediation: Results Over Time and in Different Contexts. *Educational Evaluation and Policy Analysis, 41*(3), 294-315. https://10.3102/0162373719848777

Mangan, K. (2021). Could the Summer Slide Become a Covid Crash?: Pandemic learning loss threatens to turn achievement gaps into chasms. *The Chronicle of Higher* Education. https://go.exlibris.link/JCmqBhMy

Miles, M. B., Huberman, A. M., Saldana, J. (2020). Qualitative data analysis: *A methods sourcebook* (3rd edition). Sage.Ragsdale, T. L., Akin, R., & Warren, G. (2021). Co-requisite redesign leads to increased college algebra success and college completion. *Journal of Access, Retention, and Inclusion in Higher Education*, *4*(1), 5.

Richardson, C., & Dorsey, J. (2019). *Key considerations in designing co-requisite supports*. Emerging issues in mathematics pathways: Case studies, scans of the field, and recommendations, 41-54. https://dcmathpathways.org/sites/default/files/resources/2019-04/Emerging-Issues-in-Mathematics-Pathways_Chapter5.pdf

Scherer, J. L., Anson, M. L., & ProQuest (Firm). (2014). *Community colleges and the access effect: why open admissions suppresses achievement*. Palgrave Macmillan. https://10.1057/9781137331007

Schwartz, S. (2023, July 11). Students aren't rebounding from the academic effects of the pandemic. *Education Week*. https://www.edweek.org/leadership/students-arent-rebounding-from-the-academic-effects-of-the-pandemic/2023/07#:~:text=On%20average%2C%20students%20will%20need

US News Find a community college by State. (2024). *US News*. Retrieved August 9, 2024, from https://www.usnews.com/education/community-colleges/

Vygotsky, L. S. (1978). Mind in society: The development of higher psychological processes. Harvard University Press.

Yin, R. K. (2009). *Case study research: design and methods* (Fifth ed.). SAGE.

Attachment A: Student Pre-and-Post Surveys

MATH 1096 (Corequisite support course for College Algebra) Pre-Survey: If there are any questions you do not wish to answer please select/write "no response"

1. What is your age (under 18, 18-24, 25-34, 35 or more, or no response)?
2. What is your gender identity (female, non-binary/non-conforming, male, self-description, or if you prefer not to answer write no response)?
3. What is your racial or ethnic background (American Indian or Alaska Native, Asian, Black or African American, Multiracial, Native Hawaiian or other Pacific Islander, White, Self-description or no response)?
4. What is the last math class you have taken (be specific on subject and if high school or college level)?
5. On a scale of 1-5, how comfortable are you with mathematics?
    1 - Not at all comfortable
    2 - Slightly comfortable
    3 - Moderately comfortable
    4 - Very comfortable
    5 - Extremely comfortable
6. On a scale of 1-5, how confident are you in your ability to learn mathematics?
    1 - Not at all confident
    2 - Slightly confident
    3 - Moderately confident
    4 - Very confident
    5 - Extremely confident
7. On a scale of 1-5, how much do you enjoy learning mathematics?
    1 - Not at all enjoyable
    2 - Slightly enjoyable
    3 - Moderately enjoyable
    4 - Very enjoyable
    5 - Extremely enjoyable
8. On a scale of 1-5, how much do you think the supplemental math course will assist you in College Algebra?
    1 - Not at all
    2 - Slightly
    3 - Moderately
    4 - Very
    5 - Extremely
9. On a scale of 1-5, how much do you agree with the statement "I have the ability to do the skills required for College Algebra"?
    1 - Not at all
    2 - Slightly

3 - Moderately
4 - Very
5 - Extremely

10. On a scale of 1-5, how important do you think College Algebra is to your academic success?
    1 - Not at all important
    2 - Slightly important
    3 - Moderately important
    4 - Very important
    5 - Extremely important

MATH 1096 (Corequisite support course for College Algebra) Post-Survey:
If there are any questions you do not wish to answer please select/write "no response"

1. How comfortable are you with mathematics now, after taking this course?
    1 - Not at all comfortable
    2 - Slightly comfortable
    3 - Moderately comfortable
    4 - Very comfortable
    5 - Extremely comfortable
2. How confident are you in your ability to learn mathematics now, after taking this course?
    1 - Not at all confident
    2 - Slightly confident
    3 - Moderately confident
    4 - Very confident
    5 - Extremely confident
3. How much do you enjoy learning mathematics now, after taking this course?
    1 - Not at all enjoyable
    2 - Slightly enjoyable
    3 - Moderately enjoyable
    4 - Very enjoyable
    5 - Extremely enjoyable
4. How much do you think the supplemental math course helped you in College Algebra?
    1 - Not at all
    2 - Slightly
    3 - Moderately
    4 - Very

5 - Extremely

5. How much do you agree with the statement "I have the ability to do the skills required for College Algebra"?

    1 - Not at all
    2 - Slightly
    3 - Moderately
    4 - Very
    5 - Extremely

6. How important do you think College Algebra is to your academic success now, after taking this course?

    1 - Not at all important
    2 - Slightly important
    3 - Moderately important
    4 - Very important
    5 - Extremely important

7. What were the least helpful aspects of this co-requisite course?
8. What were the most helpful aspects of this co-requisite course?
9. What advice would you give to future students taking this co-requisite course?
10. Would you recommend this course to other students? Why or why not?
11. Do you have any additional comments you wish to share regarding learning strategies, practice, challenges, support, etc.?

MATH 1021 (College Algebra) Pre-Survey:
If there are any questions you do not wish to answer, please select/write "no response"

1. What is your age (under 18, 18-24, 25-34, 35 or more, or no response)?
2. What is your gender identity (female, non-binary/non-conforming, male, self-description, or if you prefer not to answer write no response)?
3. What is your racial or ethnic background (American Indian or Alaska Native, Asian, Black or African American, Multiracial, Native Hawaiian or other Pacific Islander, White, Self-description or no response)?
4. Did you complete any of the college developmental sequence prerequisite courses prior to this class, or did your math placement place you into this College Algebra class?
5. On a scale of 1-5, how comfortable are you with mathematics?

    1 - Not at all comfortable
    2 - Slightly comfortable
    3 - Moderately comfortable

4 - Very comfortable
5 - Extremely comfortable

6. On a scale of 1-5, how confident are you in your ability to learn mathematics?
1 - Not at all confident
2 - Slightly confident
3 - Moderately confident
4 - Very confident
5 - Extremely confident

7. On a scale of 1-5, how much do you enjoy learning mathematics?
1 - Not at all enjoyable
2 - Slightly enjoyable
3 - Moderately enjoyable
4 - Very enjoyable
5 - Extremely enjoyable

8. On a scale of 1-5, how prepared do you feel for College Algebra?
1 - Not at all
2 - Slightly
3 - Moderately
4 - Very
5 - Extremely

9. On a scale of 1-5, how much do you agree with the statement "I have the ability to do the skills required for College Algebra"?
1 - Not at all
2 - Slightly
3 - Moderately
4 - Very
5 - Extremely

10. On a scale of 1-5, how important do you think College Algebra is to your academic success?
1 - Not at all important
2 - Slightly important
3 - Moderately important
4 - Very important
5 - Extremely important

11. Did you register for supplemental corequisite MATH1096, if yes state why you chose to do so, and if no state why you did not choose to participate in that course?

MATH 1021 (College Algebra) Post-Survey:
If there are any questions you do not wish to answer, please select/write "no response"

1. How comfortable are you with mathematics now, after taking this course?

    1 - Not at all comfortable
    2 - Slightly comfortable
    3 - Moderately comfortable
    4 - Very comfortable
    5 - Extremely comfortable

1. How confident are you in your ability to learn mathematics now, after taking this course?

    1 - Not at all confident
    2 - Slightly confident
    3 - Moderately confident
    4 - Very confident
    5 - Extremely confident

2. How much do you enjoy learning mathematics now, after taking this course?

    1 - Not at all enjoyable
    2 - Slightly enjoyable
    3 - Moderately enjoyable
    4 - Very enjoyable
    5 - Extremely enjoyable

3. How would you characterize your math skills preparation for College Algebra after taking this course?

    1 - Not at all prepared
    2 - Slightly prepared
    3 - Moderately prepared
    4 - Very prepared
    5 - Extremely prepared

4. How much do you agree with the statement "I have the ability to do the skills required for College Algebra"?

    1 - Not at all
    2 - Slightly
    3 - Moderately
    4 - Very
    5 - Extremely

5. How important do you think College Algebra is to your academic success now, after taking this course?

    1 - Not at all important
    2 - Slightly important
    3 - Moderately important
    4 - Very important
    5 - Extremely important

6. What were the least helpful aspects of this College Algebra course?
7. What were the most helpful aspects of this College Algebra course?
8. What advice would you give to future students taking this College Algebra course (specifically, how should students prepare for this course)?
   10. If you registered for MATH1096 corequisite, would you recommend future students take that course to supplement College Algebra (please provide details on why or why not)?
9. If you did not register for MATH1096, after taking College Algebra do you think you would reconsider and recommend future students take that corequisite course to supplement College Algebra (please provide details on why or why not)?
10. Do you have any additional comments you wish to share regarding learning strategies, practice, challenges, support, etc.?

Attachment B: Student Focus Group Questions
Semi-Structured Interview Guideline (30-45minutes).

Thank you so much for volunteering to participate. We appreciate your opinions and input, and we are glad you are sharing your thoughts today. And if any question makes you uncomfortable you can choose not to reply and go onto another question.

1. How would you describe your "relationship" with mathematics? Prompts: do you enjoy it, appreciate it, fear it, etc.
2. How would you characterize yourself as a mathematics learner (good, nervous, etc.)
3. What do you think is important about mathematics?
4. Why do you think math is relevant or not?
5. How do you feel that math is related to you and your life?
6. What were your past experiences with math classes and compare that with current experience in MATH1021?
7. What has been your experience in MATH1096 (for those in the corequisite course)?
   Prompts: What is helpful? What is a challenge? What support, if any, does the corequisite course provide?
8. If you are not in the corequisite Math 1096 course why did you choose not to be in MATH1096?
   Prompts: Did you receive guidance/support from teachers/mentors/administrators in this choice? Did you feel support from family/friends/school on decision? After completing College Algebra would you rethink option of registering for MATH1096 support class?
9. What has been your experience in MATH1021 College Algebra?
   Prompts: What has been helpful, what has been a challenge? What would you recommend to support achievement?
10. How would you describe your mathematics ability prior to your current MATH1096 course and how would you describe your ability now? What changed (if applicable)
11. If you are in Math 1096, what do you like about the learning environment in MATH1096? What would you change or improve about the learning environment?

Prompt: How does MATH1096 prepare you or not for MATH 1021

12. What do you like about the learning environment in MATH1021? What would you change or improve about the learning environment?

Attachment C: Professor Reflection Prompts

1. Faculty Name
2. Topic(s) covered this week in Math 1021 (College Algebra Course)
3. Topic(s) covered this week in Math 1096 (CO-REQ Class)
4. Evidence of student engagement from this week.
5. What went well this week?
6. Did you have any issues or concerns with Math 1096 this week?
7. Do you have any observations regarding Math 1096 or Math 1021 from this week?
8. Additional Comments (consider any ethical issues, biases; reflect on different perspectives and approaches that you might wish to incorporate in the upcoming weeks)

Attachment D: Student Likert-Scaled Pre-and-Post Questions

Pre-Survey

1. How comfortable are you with Mathematics?
2. How confident are you in your ability to learn Mathematics?
3. How much do you enjoy learning Mathematics?
4. How much do you think the supplemental math course will assist you in learning College Algebra?
5. How much do you agree with the statement "I have the ability to do the skills required for College Algebra"?
6. How important do you think College Algebra is to your academic success?

Post-Survey

1. How comfortable are you with Mathematics now after taking this course?
2. How confident are you in your ability to learn mathematics now, after taking this course?
3. How much do you enjoy learning mathematics now, after taking this course?
4. How would you characterize your math skills preparation for College Algebra after taking this course?
5. How much do you agree with the statement "I have the ability to do the skills required for College Algebra"?
6. How important do you think College Algebra is to your academic success now, after taking this course?