"Algebra shouldn't be this hard": How Developmental Math Student Perceptions of and Prior Experience With Algebra Influence Course Relearning Experiences

Kristen Amman
University of Nebraska-Lincoln

Juan Pablo Mejía Ramos
Rutgers University

We report results from a longitudinal case study of Elementary and Intermediate Algebra students' perceptions of what it means to "relearn" algebra, and the consequences of such perceptions on relevant behaviors and affective states. This data comes from a larger project investigating student experiences relearning individual topics and reflections on relearning across two semesters of developmental math courses. We found that students often conflated their perceptions of algebra as a familiar and "simplistic" subject with the notion that they understood it, leading to the idea that relearning it should be easy. This perception was held even in the face of poor course performance and was used to motivate unproductive patterns of behavior. In identifying the unique factors that informed and reinforced students' perceptions of relearning, this report provides useful insights for educators who are currently grappling with high rates of failure and attrition in such courses nationwide.

Keywords: developmental mathematics, relearning, algebra

This report describes students' perceptions of what it means to relearn algebra in traditional developmental math courses, i.e., semester-long college courses whose content mirrors that of United States middle and high school pre-algebra and algebra courses. Such courses continue to make up a significant portion of developmental math offerings (Kosiewicz, Ngo & Fong, 2016) and are subject to the greatest scrutiny in the developmental math space. In a series of prior reports on *relearning* in this space (i.e., when current learning goals are essentially the same as those of a previous learning experience for a given student), we have demonstrated the utility of focusing on *student perceptions* of their current understanding of algebra and how such understanding is impacted by learning about it again in college (Amman & Mejía-Ramos, 2021, 2022, 2023). We have argued that such perceptions may be crucial in explaining student behaviors and learning outcomes related to specific topics in those courses. Our work contributes to a long-standing call for research on developmental mathematics education to open the "black box" of teaching and learning in such courses (Grubb, 2001; Sitomer et al., 2012; Mesa, Wladis & Watkins, 2014) to better understand what factors may contribute to their historically high failure rates (Chen, 2016; Bailey, Jeong, & Cho, 2010).

The data presented in this report come from a larger longitudinal study that sought to capture how college student perceptions of relearning evolved over two semesters in a developmental mathematics program. In this report, we present results about (1) the ways students perceive their overall experience relearning in a developmental mathematics course, and (2) the relationship between a student's perception of their developmental mathematics course experience as a whole and their evolving relationship with relearning across individual topics. In addressing these issues, we also seek to contribute to educational theory regarding relearning—a phenomenon that is present in a variety of first-year college mathematics courses. Indeed, by identifying the facets of students' perceptions of relearning that may be tied to the topic of algebra itself, we become better able to understand how student experiences might vary when relearning in courses such as college-level Precalculus or Calculus.

Literature Review

Studies seeking to describe student experiences in developmental mathematics courses typically focus on one of four areas: placement into or rates of passing developmental math courses (Moran, 2008; Benken et al., 2015; Ngo, 2020; Ngo & Velasquez, 2020; Bahr, 2012; Fong, Melguizo & Prather, 2015; Xu & Dadgar, 2018); non-cognitive variables associated with placement or passing such as academic mindsets or self-efficacy (Silva & White, 2013; Ironsmith et al., 2003; Baxter, Bates & Al-Bataineh, 2016; Hall & Ponton, 2005; Zientek et al., 2013; Higbee & Thomas, 1999; Guy, Cornick & Beckford, 2015); describing instructor perceptions of student experiences (Mesa, 2012; Er, 2018; Reichwein, Schneider & Onwuegbuzie, 2014; Grubb & Gabriner, 2013); and describing student perceptions of their own learning experiences (Cox & Dougherty; 2019; Benken et al., 2015; Mesa, 2012). The current study is of the fourth type. Studies of this type are sparse, but critical to understanding and explaining students' motivation for patterns of behavior and course engagement.

Cox and Dougherty's (2019) end-of-semester interviews with 25 community college pre-algebra students indicated that 15 of the 25 students perceived the course to be useful in "refreshing" their preexisting knowledge of pre-algebra. These students identified the overall function of the course as "reviewing" or "remembering" algebra as opposed to helping them to better understand the mathematics they had seen before. In fact, even though 18 of these students indicated that they "wanted to 'really understand'" the reasoning behind their use of procedures in the course in way that they had not accomplished previously (p. 256), only three of these students indicated that they felt this had been accomplished by the end of the course. Thus, it seems that there was some distinction between what participants may have desired from a relearning experience and what they felt the course was ultimately capable of providing to them.

Benken et al., (2015) surveyed 306 first year students placed into Intermediate Algebra at California State University. A smaller sub-finding of this study concerned student perceptions of what it meant to gain a "better" understanding of mathematics in a developmental math course in which they had already seen the material before. The authors found that some, although not all, students perceived a better understanding to mean that they had recalled material they had already learned previously. Interestingly, instructors who were also surveyed in this study indicated a perception that most students approached the course as a "review" rather than an "opportunity to learn new content". Instructors perceived such an impression negatively, and assumed it stemmed from an overconfidence in skills. However, it is important to note that studies in this category involved interviewing (Cox & Dougherty, 2019) or surveying (Benken et al., 2015) students at the end of their course experience. Thus, while each of these studies gives us important insight into students' perceptions of learning in a developmental mathematics course, they are limited in their ability to explain why such perceptions are formed by students, or how they might influence student experiences learning course content. The current study sought to complement this prior work by identifying exactly such mechanisms.

Contrary to current depictions of developmental mathematics students having one uniform "type" of learning need (for example, a "refresher" of course material or an intensive review of "basic skills", Grubb & Gabriner, 2013; Cox & Dougherty; 2019), in our own previous work (Amman & Mejía-Ramos, 2021; 2022), we have found that developmental math students' learning experiences differed substantially across time and across course topics. This was because students' judgements regarding how and when to integrate their prior algebra understanding with what they were learning in their current course were dependent on their perceptions of the similarity of the topic in the developmental math context compared to their

previous algebra classes, and their confidence in their understanding of the topic at that time. Due to variations in perceptions of similarity and confidence throughout the semester, we found that existing categories from the literature were not all-encompassing descriptors or labels for a "type" of experience (e.g., a "refresher" experience) that fit each student. In subsequent work (Amman & Mejía-Ramos, 2023) we substantiated the connection between students' expectations for what relearning might look like at different points of the course and their methods of engagement with course content. The results of this previous work departed significantly from studies that advocated for the use of broad labels to describe student experiences due to the difference in relearning experiences based on topic. However, these results do not contradict the idea of students holding more holistic impressions of what it means to relearn in a course (Cox & Dougherty, 2019; Benken et al., 2015). Rather, they motivate the necessity of research that seeks to understand the relationship between students' topic- and course-level perspectives on relearning. The current study sought to do just this—to understand how students' holistic perceptions of relearning algebra were formed and how they evolved as the course progressed.

Theoretical Framework

Traditionally, conceptualizations of relearning have been oriented around the author's notion of a successful experience. For example, in her work on learning experiences in mathematics content courses for future teachers, Zazkis (2011) describes relearning as "the learning-again of concepts and ideas that are familiar or that are perceived as familiar by the learner," (p. 9). She goes on to orient this notion around a particular successful outcome. In contrast to "simply adding knowledge to what was previously incorporated into a learner's repertoire," relearning is described as *reconstruction*—a process that involves a reframing and reorganization of prior cognitive structures from K-12 learning for the purpose of teaching (p. 12). While we have found the notion of reconstruction to be useful in prior work (Amman & Mejía-Ramos, 2023), we found that orienting the conceptualization of relearning around this outcome was less useful in understanding student learning experiences in developmental mathematics courses. We were interested in characterizing what was happening to student understanding in these courses—how their cognitive framing of algebra content was impacted by their relearning experience, even if it could not be characterized as a "successful" reconstruction.

Accordingly, we define relearning in mathematics broadly as the experience (happening at a time T2) of learning about content one has already tried to learn about in a previous mathematics course (happening at an earlier time, T1). Importantly, the second learning experience cannot be simply a review of the content for the purpose of teaching something else (this would be better characterized more simply as the activation of prior knowledge in a relevant learning experience); the learning of such content must be *the target* of learning experiences happening at both T1 and T2. We do not orient our conceptualization around specific successful learning outcomes at T1 or T2. Instead, we treat the "learning" of relearning more generally to allow for a focus on describing *how* students' existing understanding of content can be (or be perceived to be) impacted by the T1 experience, without the necessity of comparing these impacts to a successful norm. Under this conceptualization, one may study relearning at multiple grain sizes: relearning a particular topic (such as relearning *solving systems of equations*) or relearning an entire course (relearning *Algebra*). Topic-level relearning was the focus of our earlier work in developmental mathematics (Amman & Mejía-Ramos, 2021, 2022, 2023) and resulted in a broader range of possible relearning outcomes than had previously been noted in the literature. This report focuses on the "course-level" relearning—students' holistic perceptions of what learning is like overall in a course. In a previous report (Amman & Mejía-Ramos, 2023) we

presented findings that described the relationship between one Intermediate Algebra student's topic-level and course-level perceptions of relearning as she continued to encounter content involving the sub-topic of factorization throughout a developmental math course. In the current study, we focus on course-level perceptions, demonstrating how such perceptions evolve over time and come to influence students' behavioral patterns and affective responses in developmental mathematics.

Methods

We conducted a multiple, longitudinal case study over a period of three semesters, following six students enrolled in either Elementary Algebra or Intermediate Algebra at a four-year university. Elementary and Intermediate Algebra are non-credit-bearing courses whose syllabi reflect those of a typical high school algebra course. Each participant spent two consecutive semesters in the study, with three participants beginning the study in Elementary Algebra in Spring 2021 and the other three beginning in Intermediate Algebra in Fall 2021. All participants were recruited at the beginning of the semester via email for a study focused on their experiences learning about algebra in their current course. Interested students completed a survey in which they were asked about their algebra course-taking history, then shown a list of topics (and related problems) that would be taught in their current algebra course. Students described how well they remembered and how confident they were in their current understanding of each topic.

Each semester, we chose participants whose survey responses varied in terms of how well they thought they remembered and understood the given topics, and their level of experience with college algebra courses. While some participants like Jina were taking an algebra course in college for the first time, all participants reported taking at least one algebra course in middle or high school prior to their enrollment in the study. Other participants had substantial course-taking experience with college algebra, such as Danasia who had failed Elementary Algebra twice before her recruitment into the study, and Becca who had passed Elementary Algebra and subsequently failed Intermediate Algebra once prior to recruitment. This abundance of prior algebra learning experiences meant that all participants were likely to characterize at least some of their upcoming learning experience as relearning. Data collection consisted of six one-hour interviews per student, surveys, grades on course exams and responses to exam questions whenever possible. Interviews 1-4 occurred in the first semester of study enrollment and focused on student experiences relearning specific topics in their algebra course as well as larger holistic reflections on the task of relearning algebra. Interviews 5 and 6 occurred the following semester and focused more on how students' perspectives on relearning evolved over time now that they were in a different course context. Details on topic-level interview questions may be found in previous reports (Amman & Mejía-Ramos, 2022; 2023). For the sake of space, we describe the components of interviews 1-4 that focused on course-level relearning for this report.

At the end of every interview, we asked students to describe, overall, how they thought the experience of relearning in their math course had been different from learning new content in mathematics for the first time. Each student's responses to this item were carried over into subsequent interviews to probe for further reflection throughout the semester. During the fourth interview, it was not uncommon for participants to be presented with three or four responses that they had previously given to this item and asked to discuss their perception of the relationships between them. This feature of the interviews served two purposes. First, it allowed us to better understand students' evolving perceptions of relearning throughout the semester and to discuss these perceptions with them in their own words. Second, it served as a member check of preliminary codes that we might use to describe course-level relearning perceptions.

Formal analysis proceeded in multiple rounds of qualitative coding. Again, for the sake of space, we only describe analysis as it is relevant to our course-level relearning data. The first round of analysis on this data proceeded once we had already built descriptions of individual cases at the topic-level. We then coded student responses to the questions at the end of each of the four interviews in the first semester of the study in which they were asked to describe their perspective on relearning algebra and how it might differ from learning something new for the first time. Subsequent rounds of analysis involved cross-case comparisons resulting in preliminary themes that either grouped various students' course-level relearning perceptions or sought to associate a course-level perception with larger patterns of behavior and affective states across the data set. This process involved engaging in explanation-building utilizing all data sources for an individual participant, then moving to the next participant to locate commonalities across experiences and produce evidence of rival explanations if that participant experienced a similar outcome despite different combinations of the study variables (Yin, 2009). The result of this stage of analysis was a set of preliminary themes that were refined over a period of several further rounds of analysis for consistency.

Results

Discussions around relearning at the course-level centered were mainly dominated by the perspective that relearning algebra should be easy due to its familiarity and perceived simplicity relative to later topics in mathematics. All six students discussed this perspective in all four of their first semester interviews and used it to justify their level of engagement with course material. However, as will be discussed in subsequent sections, students began to experience increasing moments of cognitive dissonance around this perspective when confronted with their course performance as the semester went on.

Conflating Perceptions of Algebra Familiarity and Simplicity With Understanding

All six participants persistently described the task of relearning algebra as something that should be easy because they had learned about it before. We use the word "should" to reflect the persistence with which students held this belief even in the face of substantial difficulty with the course material. This perspective influenced the behaviors and course experiences of all participants but is perhaps best exemplified by Cara and Jina's experiences throughout Elementary and Intermediate Algebra, respectively, due to their tendency towards exposition and high degree of reflection in their interviews. Additionally, Cara and Jina serve as excellent focal points for the data set given that both participants began the study with very different levels of algebra relearning experience, with Cara having taken two prior semesters of college algebra at other institutions and Jina having Intermediate Algebra as her first math course in college.

When discussing this perspective, participants often conflated the notion of algebra being a familiar subject with the perception that they either already understood it or with the expectation that they would achieve an appropriate level of understanding in the class easily. For instance, in her first interview, Jina stated, "I've already learned [algebra], so I'm not really sure what the most difficult topic would be, whether we have gone over it in the past or not. If it was something that we went over, it would be a little bit easier to understand just 'cause I have a basic knowledge of how it would go versus if it's something completely new I think I would have a bit more trouble trying to understand." In this way, Jina describes her perception of relearning as inherently easier than learning something new due to her foundation of "basic knowledge" in the subject. This perspective was often bolstered by participants' view of algebra as a more simplistic subject in mathematics. This was exemplified in Jina's case when she

described algebra as a "very straightforward" subject, one in which problems could be solved simply by "memorizing a formula." Cara echoed this sentiment in her first interview, stating that for her almost all math at this level was memorization, adding "I know once you get further into it, it's more than that and it takes a lot, but right now it's just 'remember how to do this." In this way, students expected that their experience relearning algebra would mostly be an exercise in recalling algebraic procedures. Given that the subject of algebra was highly familiar to them, this appeared to be a task that would be easy for them to complete successfully.

As the semester went on, participants continued to hold onto this perspective, even after finding it to be at odds with the actual understanding of algebra developed during their T2 learning experience. For instance, Jina reported feeling confident that she would perform well on an Exam 1 topic that would be taught in the course because she "remember[ed] that those rules were easy to remember." That is, Jina did not have any recollection of the topic itself, but rather a sense of general familiarity with it along with a perception that understanding algebra was as simplistic as memorization and recall. However, Jina often found herself frustrated when attempting to reconcile her relearning perspective with actual course experience, stating in her fourth interview, "I keep contradicting myself cause it's like I've seen these [topics], so I'm like 'I remember it being easy, so it'll be easy' but then at the same time when I'm learning it it's kind of like, 'oh this isn't what I learned'. Cara echoed similar sentiments when she indicated on her recruitment survey that she had seen systems of equations before and remembered some of what she was taught. However, after learning about it in class, she found this perception to be false. In explaining this, she reflected, "it's probably just because like at face value it's just, you know, an easy [topic], it's not that complex." In this way, Cara and Jina, like the other participants, conflated their familiarity with algebra, along with its early introduction in the K-12 curriculum, with an actual understanding of the material. As we will see in the following section, this often led to undesirable or frustrating outcomes due to its influence over students' behaviors.

Persistent Impacts on Behavior

This conflation of perceived familiarity and simplicity with understanding of algebra was critical to participants' experiences throughout the semester, given that it was often used as a motivator for patterns of in-class behavior. For example, at the end of the semester during her fourth interview, Jina noted that despite evidence from her first exam that her understanding of algebra was often not correct or unreliable, "by exam two, I still had that mindset in the back of my mind. Like 'oh algebra shouldn't be this hard.' So then it was like some things [in class] I would listen to, but some things I would just kind of be like I like, 'I already know this' like 'I don't need to be like listening' I guess." Here we see Jina explicitly conflating her perception of algebra as something that should be easy with the notion that she already understood course material. This served as a way of motivating a pattern of disengagement from the course that she mentioned for five out of seven major course topics in Intermediate Algebra.

Cara discussed a similar association between perceptions of relearning algebra as something that should be easy and patterns of disengagement from the course. For example, in her second interview, Cara emphasized that in Elementary Algebra, "we're adults and supposed to learn quickly…faster than we did when we were younger…like you already learned this but now you're just going over it and it should be like a 'oh duh' kind of moment you know?" Like Jina, Cara's perception of the task of relearning algebra as something that should happen quickly and with relatively little effort resulted in an over-reliance on memory and a lack of engagement with course material. For example, when reflecting on her lack of success with problems involving systems of equations on a course exam, Cara stated, "I think that because of how easy it was,

once I realized what you're supposed to do, I was like 'I don't need to remember this, it's gonna be fine, I could see this anywhere and be able to solve it any day of the week.' Not the case. Not the case at all." Here, Cara seemed to initially perceive the content as almost obvious, something that she could reason through without even having an explicit memory of it. In fact, Cara stopped going to class soon after the second course exam because she felt she could recall the material on her own regardless of whether she was in class or not. This decision seemed to contradict the fact that she had scored more than 10 points lower than the class average on the first two course exams, and speaks to the persistent influence of this perception of relearning algebra on student decision-making.

Conclusions

We intend to contribute to broader literature that seeks to characterize the unique challenges inherent in the teaching and learning of developmental mathematics courses that have caused them to become the target of countless reforms (e.g. Hodara, Jaggars & Karp, 2012; Yamada & Bryk, 2016). Specifically, we focus on describing how students are interpreting the task of relearning in these courses—what, exactly, they are meant to do when learning about material they have already tried to learn about in a previous course. We believe that such a focus on student perceptions is critical given previously-noted differences in the literature between instructor's perceptions of developmental math students and students' perceptions of themselves. For instance, developmental math students are often characterized by their instructors as engaging in unproductive learning behaviors such as self-handicapping strategies (Mesa, 2012) and having poor study and time management skills (Reichwein, Schneider, & Onwuegbuzie, 2014). In contrast, students in Mesa (2012) have described themselves as preferring mastery over performance goals, a lack of engagement in self-handicapping behaviors, a disposition towards hard work, and an expectation that instructors would challenge them. Likewise, students in Cox and Dougherty's (2019) study indicated a desire to form a deep understanding of the material they were relearning, and were sometimes even disappointed by the ultimate function of the course as a "review" or "refresher." In this way, it seems that developmental math students and their instructors may hold different understandings and expectations regarding the work of relearning and how they are meant to productively engage their previously-developed understanding of algebra in this new college course context.

In addressing these concerns, it seems crucial for developmental math instructors to examine the features of their instruction or of the structure of their courses that might unintentionally support students in forming perceptions of relearning algebra that ultimately do not serve them. For instance, in this report, we stress the importance of students' judgements of algebra as a "familiar" subject. Students were often unsuccessful in making accurate judgments of familiarity on their own, believing particular topics or procedures to be something they had already learned about or understood sufficiently, then finding this to be inaccurate after receiving feedback on course exams. Given this information, it would seem reasonable for instructors to build course activities that explicitly disrupt these assumptions of familiarity, either by presenting course materials in a non-standard way (see work on restructuring college algebra around the notion of structure sense; Wladis, Sencindiver & Offenholley, 2023) or by explicitly asking students to interrogate their sense of familiarity around a topic shortly after it is introduced. Likewise, instructors may want to reflect on the way that they frame the subject of algebra while teaching, noting that suggesting that students "should" already understand the material, or should come to understand it quickly (e.g. Cox, 2015), may unintentionally support students' disengagement with course content and overreliance on their own memory of their prior understanding.

References

Amman, K., & Mejía-Ramos, P. (2021). Developmental Mathematics Students' Perceptions of (Re)learning Outcomes: The Value of Algebra All Over Again. In Olanoff, D., Johnson, K., & Spitzer, S. (Eds.), *Proceedings of the forty-third annual meeting of the North American Chapter of the International Group for the Psychology of Mathematics Education* (pp. 1336-1340). Philadelphia, PA.

Amman, K., & Mejía-Ramos, P. (2022, February). Developmental Math Students' Perceptions of (Re)learning Outcomes: The Value of Algebra All Over Again. In Smith Karunakaran, S., Higgins, A. (Eds.), *Proceedings of the 24th Annual Conference on Research in Undergraduate Mathematics Education* (pp. 19-27), Boston, MA.

Amman, K., & Mejía-Ramos, P. (2023, February). "I want this to be the last time. I don't want to teach myself anymore": Relearning Factorization from Middle School Through College. In Cook, S., Katz, B., Moore-Russo, D. (Eds.), *Proceedings of the 25th Annual Conference on Research in Undergraduate Mathematics Education* (pp. 609-617), Omaha, NE.

Bahr, P. R. (2012). Deconstructing remediation in community colleges: Exploring associations between course-taking patterns, course outcomes, and attrition from the remedial math and remedial writing sequences. *Research in Higher Education, 5*3(6), 661-693.

Bailey, T., Jeong, D. W., & Cho, S. W. (2010). Referral, enrollment, and completion in developmental education sequences in community colleges. *Economics of Education Review, 29*(2), 255-270.

Baxter, R., Bates, A., & Al-Bataineh, A. T. (2016). Developmental Mathematics Students: Who are They and What is Their Mathematics Self-Efficacy?. *International Journal of Assessment Tools in Education, 4*(1), 37-53.

Benken, B. M., Ramirez, J., Li, X., & Wetendorf, S. (2015). Developmental mathematics success: Impact of students' knowledge and attitudes. *Journal of Developmental Education, 38*(2), 14-31

Chen, X. (2016). *Remedial Coursetaking at U.S. Public 2- and 4-Year Institutions: Scope, Experiences, and Outcomes (NCES 2016-405).*Washington, DC: National Center for Education Statistics.

Cox, R. (2015). "You've got to learn the rules" A classroom-level look at low pass rates in developmental math. *Community College Review, 43*(3), 264-286.

Cox, R., & Dougherty, M. (2019). (Mis) Measuring Developmental Math Success: Classroom Participants' Perspectives on Learning. *Community College Journal of Research and Practice, 43*(4), 245-261.

Er, S. N. (2018). Mathematics readiness of first-year college students and missing necessary skills: perspectives of mathematics faculty. *Journal of Further and Higher Education, 42*(7), 937-952.

Fong, K. E., Melguizo, T., & Prather, G. (2015). Increasing success rates in developmental math: The complementary role of individual and institutional characteristics. *Research in Higher Education, 56*(7), 719–749.

Grubb, N. (2001). *From black box to Pandora's Box: Evaluating remedial/develop- mental education (CRCC Brief No. 11).* New York, NY: Teachers College, Columbia University.

Grubb, N., & Gabriner, R. (2013). *Basic skills education in community colleges: Inside and outside of classrooms.* New York, NY: Routledge.

Guy, G. M., Cornick, J., & Beckford, I. (2015). More than math: On the affective domain in developmental mathematics. *International journal for the scholarship of teaching and learning*, *9*(2), 1-5.
Hall, J. M., & Ponton, M. K. (2005). Mathematics self-efficacy of college freshman. *Journal of Developmental Education, 28*(3), 26-28, 30, 32.
Higbee, J., & Thomas, P. (1999). Affective and cognitive factors related to mathematics achievement. *Journal of Developmental Education, 23*(1), 8-10, 12, 14, 16, 32.
Hodara, M., Jaggars, S., & Karp, M. J. M. (2012). *Improving developmental education assessment and placement: Lessons from community colleges across the country. (CCRC Working Paper No. 51).* New York, NY: Community College Research Center.
Ironsmith, M., Marva, J., Harju, B., & Eppler, M. (2003). Motivation and Performance in College Students Enrolled in Self-Paced Versus Lecture-Format Remedial Mathematics Courses. *Journal of Instructional Psychology, 30*(4), 276-284.
Kosiewicz, H., Ngo, F., & Fong, K. (2016). Alternative models to deliver developmental math: Issues of use and student access. *Community College Review, 44*(3), 205-231.
Mesa, V. (2012). Achievement goal orientations of community college mathematics students and the misalignment of instructor perceptions. *Community College Review, 40*(1), 46-74.
Mesa, V., Wladis, C., & Watkins, L. (2014). Research problems in community college mathematics education: Testing the boundaries of K-12 research. *Journal for Research in Mathematics Education, 45*(2), 173-192.
Moran, K. (2008). Examining the mathematical preparedness of first year college students entering college directly from traditional high schools in Connecticut. *Research and Teaching in Developmental Education, 25*(1), 30-44.
Ngo, F. J., (2020). High school all over again: The problem of redundant college mathematics. *The Journal of Higher Education, 91*(2), 222-248.
Ngo, F. J., & Velasquez, D. (2020). Inside the math trap: Chronic math tracking from high school to community college. *Urban Education*, 1-29.
Reichwein, L., Schneider, C., & Onwuegbuzie, A. (2014). Instructors perceptions about student success and placement in developmental mathematics courses. *The Community College Enterprise, 20*(1), 67-84.
Silva, E., & White, T. (2013). *Pathways to improvement: Using psychological strategies to help college students master developmental math.* Stanford, CA: Carnegie Foundation for the Advancement of Teaching.
Sitomer, A., Strom, A., Mesa, V., Duranczyk, I., Nabb, K., Smith, J., & Yannotta, M. (2012). Moving from Anecdote to Evidence: A Proposed Research Agenda in Community College Mathematics Education. *The MathAMATYC Educator, 4*(1), 35-40.
Wladis, C., Sencindiver, B., & Offenholley, K. (2023, February). Reconceptualizing Algebraic Transformation as a Process of Substitution Equivalence. In Cook, S., Katz, B., Moore-Russo, D. (Eds.), *Proceedings of the 25th Annual Conference on Research in Undergraduate Mathematics Education* (pp. 851-863), Omaha, Nebraska.
Xu, D., & Dadgar, M. (2018). How effective are community college remedial math courses for students with the lowest math skills? *Community College Review, 46*(1), 62-81.
Yamada, H., & Bryk, A. S. (2016). Assessing the first two years' effectiveness of Statway®: A multilevel model with propensity score matching. *Community College Review, 44*(3), 179-204.
Yin, R. (2009). *Case Study Research Design and Methods (Vol. 4).* Thousand Oaks, CA: Sage.

Zientek, L. R., Yetkiner, Z. E., Fong, C. J., & Griffin, M. (2013). Student success in developmental mathematics courses. *Community College Journal of Research and Practice, 37*(12), 990-1010.