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“I Never Learned More in My Life in Such a Short Period of Time”: Math Contextualization as Momentum toward Community College Student Success

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ABSTRACT

Math courses serve as cornerstones to most, if not all, community college programs. Yet, these courses continue to be gatekeepers. Contextualization represents a promising venue through which instructors might break down math barriers for students. This study explores community college students' learning experiences in contextualized math classes, and how those experiences shape momentum toward success. We used a narrative inquiry approach, drawing upon the stories of six students enrolled in two contextualized math courses at a two-year college in a Midwestern state. Interviews, field notes, and survey data helped build and deepen the students' narratives. We presented each student's narrative individually, detailing their experiences in the contextualized math classes. We also discussed the thematic analysis results, which revealed six themes. The first three themes spoke to clear expectations and learning path in math, digging into and building upon math content and knowledge, and individual and group work dynamics. The latter three themes centered on discovering and recognizing utility of math, building and translating a foundation in math, and situating math within broader education and goals. This study offers empirical evidence on the potential of contextualization to enhance community college students' learning experiences and success in math, particularly across college-level math courses and various program areas.

Math courses serve as cornerstones to most, if not all, community college programs. Yet, for community college students placing into developmental math, only half pass their required course or sequence (Chen, 2016). This completion rate is similar for students beginning in college-level math, with about 48% of those students completing (Chen, 2016). Instead of fundamental gateways, math courses can become gatekeepers, slowing or even halting students' college progression toward their educational and career goals (Xu & Jaggars, 2011).

Community colleges have sought out a number of potential strategies to reform math education, including integrating innovative teaching approaches (Burdman et al., 2018). Contextualization represents a promising venue through which instructors might break down math barriers for students. Through engaging students in “authentic, relevant contexts and real data” (Yamada et al., 2018, p. 261), contextualization refers to a broad set of approaches that connect math concepts and content with real-life circumstances, and help students maintain interest and motivation in learning math. Empirical evidence has demonstrated the positive impact of contextualization on community college student outcomes (e.g., Jenkins et al., 2009; Parker et al., 2018; Quarles & Davis, 2017; Yamada et al., 2018) and experiences (e.g., Wang, Sun et al., 2017), with much of this work focusing on developmental math courses.

Considering that math—not only at the developmental level but also the college level—continues to be a barrier to community college student success, contextualization may help remove the math hurdle through presenting meaningful connections between math and the world. Drawing upon a contextualized approach, students' learning experiences and outcomes may be enhanced in significant ways that would lead students to make the necessary links between math concepts and relevant applications, as well as become more engaged and confident in math. These outcomes could translate to students' overall academic and career success. We have a limited student perspective informing us on how contextualization can transform students' experiences in math (e.g., Wang, Sun et al., 2017). By expanding this viewpoint with additional, rigorous research on college-level math courses, we can gain better insight not only into how contextualization can enhance student experiences and self-efficacy, but also into how it can help build momentum toward success in a range of math classes, college as a whole, and beyond.

At the institutional level, contextualization represents a feasible approach to resolving persistent challenges around math progress and success. This is especially significant, since implementing contextualization may only involve modifications to existing curriculum and faculty development opportunities, and not necessarily an overhaul drawing upon extensive institutional resources. Student voices enable community colleges to evaluate the effectiveness of contextualization to inform, improve, and potentially sustain and expand its design and implementation. Their insights may lead community colleges to contextualize across a variety of math courses. Additionally, student input can prompt community colleges to provide all faculty with training and tools to seamlessly embed these teaching techniques into their classes.

Through a narrative approach, our study focuses on students in two contextualized math courses at a singular institution and explores the following questions: 1) How do community college students describe their learning experiences in contextualized courses?; and 2) How do these learning experiences shape momentum toward their math, educational, and career success?

Review of relevant literature

We situate the current study within three strands of literature: math success in the community college, community college teaching and learning, and math contextualization in community colleges. These domains contribute to insights we have collected about the possibilities of leveraging contextualization in students' math classroom experiences.

Math success in the community college

The body of research addressing college-level math reveals that student success in these courses result in a greater likelihood of persistence and completion (Leinbach & Jenkins, 2008; Roksa & Calcagno, 2010; Wang, Wang, Wickersham et al., 2017). Specifically, Leinbach and Jenkins (2008) noted that completing gatekeeper math courses and at least 30 credits of college-level or vocational credits within the first year may boost students' likelihood of achieving milestones, such as completing basic skills requirements, credential completion, or transferring to four-year institutions. Wang, Wang, Wickersham et al. (2017) discovered that students did not have to prioritize taking math during the first semester only. In fact, completing required math in the fourth and fifth terms, in addition to the first, led to higher credential completion (Wang, Wang, Wickersham et al., 2017). Students who passed college-level math courses also demonstrate twice the likelihood of transferring to a four-year institution (Roksa & Calcagno, 2010). At the same time, college-level math completion rates remain low (e.g., Chen, 2016). Acknowledging this persistent issue around math success, many states, community colleges, and researchers have looked to various solutions in enhancing course experiences and outcomes. One strategy includes examining the teaching and learning of math in community colleges to identify and potentially remove any challenges and barriers.

Community college math teaching and learning

The limited work on teaching and learning in the community college reveals that instruction tends to revolve around traditional approaches of lecture and knowledge transmission (Grubb et al., 1999). This positions instructors as knowledge keepers and transmitters, while students are passive recipients of content. This traditional mode is particularly prevalent in college-level math courses (Edwards et al., 2015). In math classes that integrate greater student involvement, instruction still tends to entail facts and procedures over concepts and making sense of math (Mesa et al., 2014). Moreover, though most math department faculty have degrees in math or other fields, few have pedagogical coursework or qualifications (Grubb et al., 1999). Faculty may rely on traditional lecturing they were exposed to instead of student-centered approaches (Edwards et al., 2015; Howington et al., 2015).

While the traditional lecture-based, instructor-centered math class has prevailed in community colleges, more recently, institutions, practitioners, and researchers have looked to distinct strategies to improve students' learning experiences and outcomes. This search resulted in a shift toward student-centered approaches, situating learning as an active, collaborative process that results in rich discussions and making meaning of course content and concepts (Edwards et al., 2015). A meaning-making approach, connecting math concepts to students' lives, appears effective in tandem with other instructional models, as faculty adapt based on students' needs (Mesa et al., 2014). Contextualization is one emergent student-centered strategy.

Math contextualization in community colleges

Contextualization has gained attention as a viable practice that aims to help students see relationships between what they learn and relevant experiences in their lives, as well as the interconnectedness of ideas (Johnson, 2002). Math contextualization contains various elements, including productive struggle (i.e., working on challenging but attainable math problems), group work or collaboration, hands-on workshops or activities, explicit connections between math concepts and program areas or real-life scenarios, among others (Perin, 2011; Wang, Sun et al., 2017; Yamada et al., 2018).¹ These approaches are especially prominent in developmental math.

Organizations and institutions have developed and integrated contextualization in a variety of ways, from the Quantway program by the Carnegie Foundation (Yamada et al., 2018) to homegrown contextualized courses with complementary workshops (Wang, Sun et al., 2017). Student outcomes and experiences with math contextualization prove favorable, including higher course performance, test scores, and completion; earning more programmatic credits; continuous enrollment; and credential completion, as compared to students not enrolled in contextualized courses (Jenkins et al., 2009; Parker et al., 2018; Quarles & Davis, 2017; Skuratowicz et al., 2020; Yamada et al., 2018). The collaborative, hands-on activities contribute to students' higher self-efficacy and motivation to persist and complete their programs (Wang, Sun et al., 2017). Contextualization not only creates enjoyable learning experiences and boosts students' self-confidence, but it also improves short- and long-term academic achievement.

Despite initial research in favor of contextualization, these efforts have been concentrated to basic skills and the developmental level (e.g., Jenkins et al., 2009; Parker et al., 2018; Wang, Sun et al., 2017; Yamada et al., 2018), even though college-level math completion rates remain the same as those for developmental math courses. It stands to reason that this approach may also offer positive impacts for college-level math courses. Our study builds upon the existing knowledge base by exploring community college students' experiences in college-level contextualized math courses and how those experiences shape momentum (Wang, 2017) in math and toward their education and career. Student insights hold great potential to help us determine what works in math teaching and learning, including contextualized instruction.

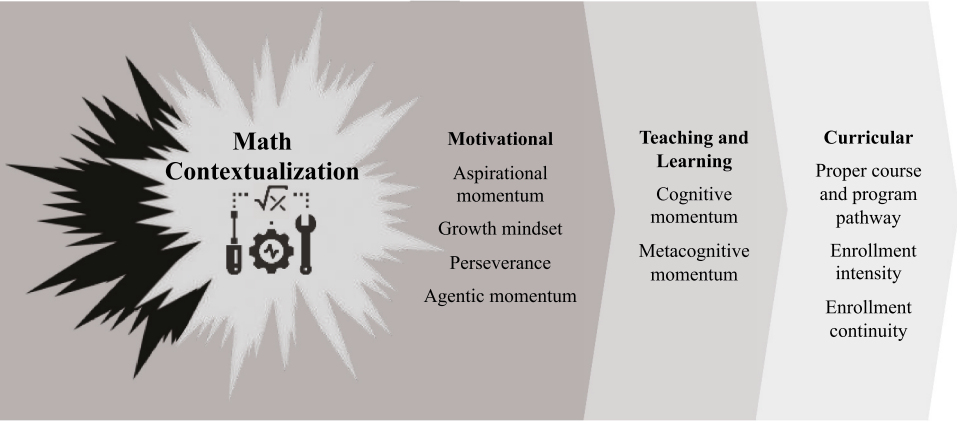


Figure 1. Conceptual framework for the study.

Conceptual framework

This study is guided by the Momentum for Community College Student Success model (also known as the momentum model) advanced by Wang (2017). This model accounts for not only student progression through college, but also what unfolds in the classroom and at the individual level that holistically shape students’ educational trajectories. Wang presents “three main domains of momentum: curricular, teaching and learning, and motivational” (2017, p. 282). The curricular domain focuses on students’ course-taking patterns and related efforts, including course sequences, enrollment intensity, and enrollment continuity. The teaching and learning domain involves cognitive (i.e., learning and mastering various topics and content) and metacognitive momentum (i.e., strategizing and assessing one’s learning) that students may develop through the classroom. The motivational domain contains agency, aspirations, mind-sets, and perseverance that can influence whether students stay on their educational path.

For the current study, we situate the momentum model within the context of community college math teaching and learning. We focus on math contextualization and how students’ experiences in the classroom with this instructional approach can act as a catalyst across the domains toward success in math and other educational and career goals (see Figure 1). For example, productive struggle, one feature of contextualization, may provide opportunities for students to wrestle with math toward cultivating growth mind-set in the motivational domain. In turn, growth mind-set can activate perseverance despite challenges in math and math self-efficacy. Motivational momentum may then spill over into other domains. Students’ increased perseverance and self-efficacy in math through contextualization may boost learning and mastery of math (teaching and learning domain). This confidence and determination may lead to continued enrollment in other math and/or program courses (curricular domain), thus helping students maintain and build forward momentum in college and beyond. We advance the model by examining particular courses (i.e., college-level math) and disciplines (i.e., electronics and construction and remodeling), offering a unique lens of how contextualization can capitalize on these courses and program areas toward momentum, engagement, and persistence.

Methods

Study overview

This qualitative study stems from a three-year mixed methods research project exploring contextualization of developmental and college math courses across math and technical education departments at two large, comprehensive two-year colleges in the Midwest. We focused on one institution, which we call Two Lakes College (TLC). As a result of contextualization professional development, two TLC faculty members revised and fully contextualized their college-level math courses. These courses included a vocational math course (situated within the math department) and an applied electronic math course (electronic technology department). Contextualization varied with each instructor's unique approach, involving a range of group work, productive struggle, intentional connections between math concepts and disciplinary/workforce context, and hands-on exercises using classroom tools (e.g., tape measures, circuits). This approach may manifest differently across programmatic contexts (Wang, Wang, Prevost et al., 2017), such as welding versus a college algebra course, impacting the extent to which faculty contextualize content area and curriculum. Nonetheless, these activities differed from those in non-contextualized vocational math or applied electronic math courses.

In a non-contextualized applied electronic math course, class sessions concentrated on lecture of math concepts, followed by a lab of applications to electronics. In the contextualized version of the course, group work and productive struggle served as predominant activities, along with hands-on or applied work. Moreover, the faculty member served as a facilitator. This meant minimum, punctuated lecture. If students were wrestling to find a solution, the faculty member, instead of providing the answer, would pose questions to help students productively arrive at a solution among themselves. As an example, in groups, students designed circuits for various light-up greeting cards through engaging in tasks such as figuring out load, power consumption, and resistance. For vocational math, the non-contextualized course was dominated by lecture, whereas the contextualized counterpart relied on group work, productive struggle, hands-on activities using industry scenarios, and the instructor as facilitator. A sample activity entailed students verifying linear feet of sill plate materials to frame a floor for a house.

Research design

We employed narrative inquiry given our line of research and focus on “first-person accounts of experience” (Merriam & Tisdell, 2016, p. 34) with contextualization. Narrative inquiry is helpful in capturing and honoring the complex and developmental process of learning (Kim, 2016). We do not assume learning, including math learning, to be a linear, apparent process confined to a classroom. Narrative inquiry allowed us to delve into the dynamic and multi-faceted nature of math teaching and learning with contextualization and students' experiences within classroom spaces and beyond.

Sample

Eleven students enrolled in the vocational math course and 24 enrolled in the applied electronic math course. Table 1 details the sample's demographic and background information. Given the nature of narrative inquiry, a small sample size is warranted, as this approach intentionally conducts an in-depth exploration of the experiences and stories of small groups of individuals (Creswell, 2013). The smaller sample permitted us to extensively examine students within contextualized math classes.

Data collection and analysis

Narrative inquiry integrates a variety of data sources, including documents, observations, interviews, and field notes, among others (Merriam & Tisdell, 2016). Interviews tend to be the most significant form of data with narrative inquiry, as they contain beliefs, experiences, and knowledge as shared

Table 1. Study sample at Two Lakes College.

Course Name	Applied Electronic Math 1		Vocational Math 1	
	N	%	N	%
Gender				
Women	1	4%	0	0%
Men	23	96%	11	100%
Race/Ethnicity				
African American/Black	2	8%	1	9%
American Indian	0	0%	0	0%
Asian	3	13%	0	0%
Hispanic	3	13%	2	18%
Multiracial	1	4%	1	9%
White	15	62%	7	64%
First-Generation Status				
First-Generation	15	63%	3	27%
Not First-Generation	9	37%	8	73%
Enrollment Status				
Full	15	63%	10	91%
Three-Quarter	1	4%	0	0%
Half	7	29%	0	0%
Less Than Half	1	4%	1	9%
Student Age				
18–24	19	79%	11	100%
25–29	2	8%	0	0%
30 and older	3	13%	0	0%
Total	24		11	

through stories by participants (Kim, 2016). Aligning with our study, interviews represented the primary source of data, with field notes and survey data as secondary, complementary pieces of data toward constructing students’ narratives.

We recruited students by e-mail and phone to invite them to participate in the study. Two students from the vocational math and four students from the applied electronic math courses consented to the interviews. See Table 2 for participants’ backgrounds. We conducted in-person, semi-structured interviews with students on a college campus or at a location of the students’ choosing. One exception was an interview that took place via phone due to geographical constraints. The interviews were up to 50 minutes in duration, with interview questions broadly centering on students’ experiences within the contextualized math courses, prior math experiences, their self-perceptions as math learners, and their educational and career plans having completed the contextualized math courses. We audio recorded the interviews and transcribed them verbatim. We integrated field notes to further enrich students’ narratives.

We engaged in coding and analytical strategies in alignment with a narrative approach to construct the students’ stories. Applying descriptive and narrative coding helped us explore and capture the students’ stories of and experiences (Saldaña, 2013) with contextualization. We also used in vivo

Table 2. Study participants and background information.

Study Name	Race/Ethnicity	Gender	Age	Enrollment Status	First-Generation Status	Program of Study
Aaron	White	Man	25–29	Half	Not First-Generation	Electrical Engineering Technology
Alex	White	Man	18–24	Full	Not First-Generation	Construction and Remodeling
Flynn	White	Man	18–24	Full	Not First-Generation	Construction and Remodeling
Kevin	White	Man	18–24	Full	First-Generation	Electrical Engineering Technology
Micah	African American/Black	Man	18–24	Full	First-Generation	Electronics
Nick	White	Man	30 and older	Full	Not First-Generation	Electrical Engineering Technology

coding to honor and draw upon students' own voices within those stories. This coding strategy allowed us to build a foundation toward narratives of community college students' experiences with contextualization and related patterns that emerged. We coded each transcript separately and engaged in discussions upon completing transcripts to identify overlapping codes and notable differences and recalibrate as needed. Doing so enabled us to identify similarities and differences across narratives, develop categories, and reconcile variations in how we interpreted participants' stories. We incorporated field notes and survey data to deepen and explore any alignment or departure based on students' stories. Together, we converged upon common categories that honored the codes and stories. We engaged in thematic analysis (Riessman, 2008) to compare across narratives and arrive at themes. This iterative process ensured the themes reflected the research questions and the students' stories.

When organizing students' stories, we relied on a combination of three-dimensional narrative space (Clandinin & Connelly, 2000) and plot structure (Yussen & Ozcan, 1996). The three-dimensional narrative space helped us understand students' narratives based on three components: interaction, continuity, and situation. Interaction allowed us to examine participants' personal and social lenses, noting how they described their internal and interpersonal experiences. Continuity entailed arranging participants' descriptions of their stories into past, present, or future. Situation entailed the place(s) with respect to physical spaces or those within students' stories. The plot structure further illuminated five essential components of each participant's narrative: characters, setting, problem, actions, and resolution. This process allowed us to see each student's experience as a unique story with various angles, contexts, and turning points. See Figure 2 for an illustrative excerpt of the narrative organization process.

Trustworthiness

We triangulated qualitative data across several sources, including interviews, field notes and survey data, to afford rich and complementary findings (Miles et al., 2019) and cross-checking (Merriam & Tisdell, 2016). We also engaged in peer review (Lincoln & Guba, 1985), which established an external

Characters		Setting		Problem		Actions		Resolution	
- Interviewers - Interviewee - Instructor - Classmates - Brother - Father		- Two-year college - Prior four-year institution - Construction and modeling program - Vocational math class - Work sites		- Not performing well at previous college - Finding a major that fits - Not seeing himself as good in math - Math teaching and learning too quick and questioning relevance		- Transferred to two-year college - Found fitting program in construction and remodeling - Took vocational math course - Engaged in internships		- Feels he can do math - Graduating program - Entering workforce - Clear work goals to progress in his line of work	

Interaction		Continuity			Situation/Place
Personal	Social	Past	Present	Future	
Reserved	Talked with other students about taking vocational math class Instructor teaching students Students work on assignments together Students helped one another in class	High school math was a challenge	Recently obtained construction job; working there part-time and full-time once semester ends	Hopes to obtain a managerial position in construction job	Lounge area in main building
Thoughtful/reflective		Failed math class last year			Vocational math course classroom
Did not feel like a four-year (bachelor's) plan was for him		Previously attended four-year college	Taking fundamentals 2 class related to building and carpentry		Workshop
Viewed himself as bad in math, not a math person		Was a baseball player and communication/political science major	Taking remodeling class		House
Believes material in vocational math class is useful in other classes		Took vocational math class			
Likes to build things		Construction internships			Construction sites
More motivated and confident in math					

Figure 2. Example segments of the narrative development process.

check (Lincoln & Guba, 1985) and probing for any biases in the data analysis process (Shenton, 2004). This interrogation of our methods, analysis, and findings also ensured the credibility of the study. Finally, we aimed for confirmability, which enables future researchers to have a clear sense of the steps we took. We carefully outlined and recorded our methods and analytical procedures along the way, noting assumptions and thought processes to illustrate how they shaped our interpretations (Miles et al., 2019) and emergent findings.

Limitations

We recognize that all six participants are men, which may present a more narrowed experience of contextualization. While this was not the study's intentional population of focus, we acknowledge that this may inhibit a well-rounded portrayal of student experiences with contextualization. At the same time, the contextualized classes consisted of almost, if not all, men, which is characteristic of technical education programs (Lester, 2010). We also examined one two-year college in a Midwest state. Nonetheless, the rich narratives and description offered through our research design (Miles et al., 2019) and student voices allow transferability (Merriam & Tisdell, 2016) to other colleges with similar efforts, programs, and students.

Results

In this section, we present narratives detailing students' experiences in contextualized math courses, followed by the culminating thematic analysis based on the students' stories.

Aaron

Aaron started at TLC in the fall of 2017 after seven years of working as an electrician. Pursuing a career in electrical engineering, he enrolled in the applied electronic math course upon having positive interactions with the instructor in other contexts. Aaron used math every day, but the "guts of electronics" was a different realm for him, including the math involved.

As a "hands-on learner," Aaron valued his instructor's approach of deconstructing problems. The instructor then "would build you back up" by indicating, "This is the truest facts of what we have . . . and this is how we can start working with it, building on it, and then ultimately reach our solution." For Aaron, this process resulted in an "aha moment instantaneously and it was just clicking with me right away. I was understanding it."

While initially having no expectations of the class, he resonated with its format of alternating between lectures and discussions. He also valued the "crystal clear" directions from his instructor to know what to anticipate each week:

Anyone who takes the five minutes and read "Hey, these are the expectations, this is what you're gonna learn, this is what you're gonna do," they should really have no problem going in there. And on the first day it's "Okay, I'm ready to learn. I'm ready. I know what I'm getting into."

Since the course allowed students to process math independently and at their own pace, Aaron felt confident "to work ahead a little bit" and reviewed upcoming class units in advance to "see what the next section is going to be about." He said, "I could really just take my time on everything and figure it out at my own pace." Aaron added, "I definitely felt like I had gotten a much more solid grasp on [manipulating equations] after that class."

In his current job, Aaron operates with commercial building fire alarm systems. He found class problems on determining voltage to be helpful, a stark contrast to his other classes where he did not see clear connections between course problems and his job responsibilities. Aaron said he "would definitely be using the equations that we learned about in that class." He elaborated on the course reaffirming his goals:

[The math course has] really kind of strengthened my decision to continue with it and keep moving forward with it. . . . It gave me that little taste of “This is what it will be like,” and I was like, “That’s what I want. That’s why I want to keep moving forward.”

Alex

As a student athlete playing baseball, Alex began his college journey at a four-year institution: “I was a communication and political science major, and did not do too well there, kind of got into the whole like college freshman thing, had too much fun.” His parents and brother all had a bachelor’s degree or higher. Although the four-year plan was expected, Alex found it was not for him. Upon dropping out, he visited TLC, which he toured before, and immediately identified his passion: construction and remodeling. He “picked the major in five minutes, and then I just fell in love with that, right from the start, and so here I am.”

Alex’s past math experiences contributed to his skepticism of vocational math:

I really was bad at math. I actually failed my math class last year. Um, and just because I’ve never really been a math person, but it made me realize that I can do math if it’s involved in the right topic, like I really enjoyed building things, and if you involve it with that, then I would enjoy that math as well.

But the contextualized course he took was different: “I’ve always known how to do like the area and perimeter and all that stuff, but he [instructor] just kind of like put it back in your head.”

During each class, Alex’s instructor composed “a set to-do list right on the board,” allowing him to draw clear expectations for each lesson. Alex also appreciated how his instructor recognized students’ varying abilities and adjusted the pacing accordingly:

He definitely did have times where he was like, “Alright, we should probably slow this down. Some of you guys are not getting this.” So he would slow it down . . . wait till everybody or the vast majority of everybody really just had it honed in, and the remainder of the people who didn’t have it down, they would get help from the other students.

Unlike previous classes in which he did not find the utility of math, Alex found the real-life scenarios that his instructor incorporated to be very helpful. He summed this up: “I never really saw how to use them [math concepts] in real life, but this is legitimately my real-life math that I use on a day-to-day basis . . . now that I know why I’m doing it, I’m eager to learn more.”

Not only did the vocational math class lay crucial groundwork in math for Alex, but he was able to take what he learned and transfer it to his other classes: “I would go from my math class immediately to my other class, and be like, ‘Alright, I just did this.’ And I knew how to do it right away.” He detailed the class impact:

I never learned more in my life in such a short period of time . . . and so it’s just like crazy learning so much and not really feeling like I’ve been learning that much . . . And your math classes are involved in your normal class. Everything is just integrated.

Flynn

Flynn was finishing a construction and remodeling program with hopes of entering into an apprenticeship. He had taken algebra and trigonometry in high school: “I understood math. I just never wanted to be – or excel in math . . . I just was never the best in math.” He figured that taking the vocational math course would be another “bullshit math class.” It was far from it.

Instead, Flynn was emphatic about the course content having great value in his program and future career. The course helped in “making sense of doing math in the field” as he took flooring measurements for a house he was involved in renovating. Flynn noted the incremental process of putting math

information together toward a solution and greater comprehension of math when he was “reading the tape measure, took the math, put it on paper, and you drew it out and figured everything out from there.”

Additionally, Flynn found the textbook to be “very easy to understand. Everything was right there, right in front of you, and the scenarios were in the book.” While Flynn said he would rather be building than solving math problems, the course examples helped him “understand why I was doing the math.” Flynn affirmed that the math foundation was necessary because “you’re doing math every single day in the classrooms that we are in.” He expressed valuing vocational math in further empowering him to recognize, understand, and apply math in the field.

Kevin

A fascination with electronics pushed Kevin toward electrical engineering and aspirations of a bachelor’s degree. He considered himself not “terribly financially stable,” leading him to enroll in the electrical engineering technology program at TLC so he could affordably fulfill his goals. Although Kevin knew what he wanted to do, he was not entirely sure the applied electronic math course would connect with him and move him along toward his goals: “I took a calculus course in high school, I took trig, but it was so broad, and it didn’t like help me determine a career out of it.” He was uncertain, but he went ahead and took the course.

Kevin was pleasantly surprised by the course. It was nothing like the math courses he took before. It was very focused, showing him how to “use this part of trig and this part of calc, and learn how to analyze this.” The course drew upon all kinds of areas and levels of math but was very specific in terms of where to use it. There was also a breaking down of math and building up of math comprehension: “It was like a step-by-step process on how to take all of these past steps and put it into the next step, and it would lead to like a bigger, bigger congregation of knowledge.” Kevin appreciated the scaffolding of math.

Another enjoyable surprise was that the class involved a lot of group work, which helped Kevin see and understand math in different ways. Students could work in groups to find solutions to math problems, and the instructor integrated regular opportunities for students to explain math concepts and answers to one another. This made a huge difference to Kevin during a review for an upcoming exam. He was struggling with a particular theorem, Norton’s Theorem:

... for some reason, I wasn’t just understanding the concept. And one of my friends drew the diagram on the board and was like, “Okay, you have to look at it from this way, and like move this here.” And then I was like, “Oh, that’s perfect. I get it.” And so that was like the day of the exam, which was very helpful, because I think I got this question right.

While Kevin found collaborating with students to be a helpful and encouraging process, he also valued the ability to work through course materials on his own if needed. His instructor provided enough resources and support to facilitate these different ways of working through math.

Kevin’s positive experiences in the math class changed how he saw himself as a math learner: “In high school, I thought I was like decent at math. I know I wasn’t the best.” The course helped “bring that knowledge” along, growing Kevin’s confidence and ability to see a path forward. The applied electronic math class aligned with and confirmed his future educational plans and career:

I’m really passionate about electrical engineering in that class, like “Oh, I get this, everything’s clicking,” and I was able to just excel in that course and other courses, and that reaffirmed what I want to do as a career.

After Kevin finished the course, he obtained a job at an electronic engineering company. In his work, he could see the math that he learned emerging on a regular basis: “So I can like use what I’ve learned ... and kind of determine what could have gone wrong.” He added, “[the course] really [helped] with my current job, because I can ... apply it.” Through his course experiences, Kevin felt he could better situate math in his future education and prospective line of work.

Micah

Micah started at another two-year institution in a different state in pursuit of transfer and becoming an electrical engineer. At that college, he enrolled in several math courses, or “all of those hard classes,” Micah called them. He took Calculus 1, 2, and 3, as well as calculus in high school. Micah switched to TLC to become an electronic technician instead. He felt the change would align with his interest in electronics. Plus, “it opens many doors, like, I can start my own business, or join a job that primarily fixes electronics, or join a company that makes a specific electronic for a specific client . . . It’s so many doors that I could just choose from.”

Micah enrolled in the applied electronic math class, but “didn’t have any expectations. More like that’s a class I have to take, and then finish. But when I took the class, it’s really not that complicated.” In the past, there were so many equations, and it was unclear where and when he would have to use them. This math class was clear. Everything made sense. Micah mentioned that “the structure is very simple, like you’re gonna learn this particular material.”

When laying out the math, the instructor would break it down, making it “very simple.” Even if students had little math knowledge, Micah was confident any student could pass it. This class was also flexible, allowing him to access course materials online and review them on his own as needed. He found that there were many occasions in which he collaborated with other students: “we joined groups and we’d try to tackle problems.” There was often an exchange of ideas and advice among the students to solve math problems. Micah described the math as “everything is useful.” He was able to identify how the concepts and the problems related to real-life scenarios and work. Everything he learned would be used “in the long run.”

Micah thought about his next steps in his program. He saw the applied electronic math class as something “you need to take before you move on” in general and “before you move on with super advanced stuff.” It was one piece toward higher level coursework and his degree and career goals. The course helped him transition seamlessly into other program courses. Micah was hoping to finish his program next year, “if everything goes right.” He passed the math class and was one step closer to another course, his degree, and endless job opportunities.

Nick

An aspiring electronic engineer, Nick had taken math in the past, but he did not always finish the courses. He tried calculus, but it was a struggle. Nick took a smattering of algebra courses, which went better. He was used to lectures, taking notes, and figuring math out on his own. Going into the applied electronic math course, he did not have many expectations, other than more math-based equations. However, Nick found that “the class is pretty straightforward . . . everything was laid out . . . You knew what to expect . . . and what was expected.” The class not only focused on concepts, but dug into math to understand “how it worked and the ideas behind it.” This approach resonated with Nick and made the math come easier for him.

As Nick progressed in the course, he was able to make connections between what he learned and the electronics field, which made him appreciate the utility of math. He could see “how it relates to all the electronics and the principles behind that stuff.” Nick added, “it’s definitely more helpful learning about it and actually seeing it in real life and seeing how it’s used.” Other than connecting math to electronics, he could see the class fitting into other aspects of his program: “[it] just kind of give[s] you a better understanding of some of the ideas early on in the program . . . laying the foundation and . . . getting you ready for the more involved stuff.”

Later on, Nick transitioned into a new job testing and inspecting circuit boards at an engineering company during his program. The math course came into play in his work, “figuring out how they [circuit boards] work or why they don’t work, and you just kind of learn. I’d say troubleshooting has

been very helpful.” Looking to the future, Nick would like to transfer to a four-year institution to obtain his bachelor’s degree in electronic engineering. Although he is not quite sure when he plans to go back, his math class helped pave the way toward that goal.

Looking across the narratives: Thematic analysis

Our thematic analysis revealed six themes. We arranged the themes based on our research questions. The first three reflected the first question about students’ experiences in the contextualized math courses. The latter three spoke to how students’ experiences shaped momentum toward their math, educational, and career success. We describe these themes below.

Making it “crystal clear”: Setting expectations and paving a clear learning path in math

Many students’ stories presented a stark contrast between prior math experiences and the contextualized math courses. Students tended to refer back to high school, where instructors often did not provide a clear road map of what they would learn and how it connected to different concepts. As a result, students had little to no expectations of what to anticipate with the contextualized math course, other than it could be similar to past experiences. However, as students began these courses, they found them to be clear and simple. Micah mentioned that “the structure is very simple, like you’re gonna learn this particular material.” Making everything clear, from the beginning of the course and throughout, positively shaped students’ contextualized course experiences, as reported in the survey and interviews. Students were at ease knowing what was expected of them and what they would be learning every step of the way.

Breaking it down: Digging into and building upon math content and knowledge

Students’ narratives revealed the breaking down of math as a common experience in their contextualized math classes. This breaking down of math problems was followed by a building up of knowledge and understanding of math. Aaron discussed this process: “She [the instructor] would break it all the way down to the bare bones of the equation.” His instructor would work with students to identify the information in the problem and how they could work with it and build on it toward the solution. Students’ survey responses reinforced this frequent process of figuring out what they knew, what they needed to know, and how to seek additional information to solve math problems. Kevin similarly mentioned the building up of math as “a step-by-step process . . . [that] would lead to like a bigger, bigger congregation of knowledge.” It was not about how fast or slow an instructor went through math concepts or problems; it was about depth. Digging in and doing math in an in-depth, scaffolded way was a dominant experience for these students, bringing them along toward a better understanding of and appreciation for math.

Dividing and conquering: Individual and group work dynamics

Students often noted an interplay between group and individual work. Although the instructors were there to facilitate the learning process, they provided ample time for students to both interact with one another or soak in math lessons on their own. Group work gave students the chance to work together toward solutions to math problems and learn from one another. Nick highlighted its benefits: “. . . if someone was struggling, you could kind of teach them, which was helpful, because it’s like re-emphasizing it in your head, and re-learning it, and then teaching someone else.” This regular peer teaching and learning through group work, as noted through the interviews and survey, helped students see different ways to solve math problems and reinforce concepts when teaching one another. Conversely, students also recounted moments when they could learn math independently and at their own pace. Students could process what they learned and figure out problems, but they could still reunite to discuss solutions. Individual and group work both served as important and informative spaces to further students’ understanding of math.

“Everything is useful”: Discovering and recognizing the utility of math

Students’ stories exposed prior experiences in which math meant very little to them. Through the contextualized courses, the students found parallels between the math content and concepts they learned, and how they served their current or future industry knowledge. Flynn made sense of math as he worked on building a house in his program: “You had the hands-on math . . . reading the tape measure . . . put it on paper . . . drew it out and figured everything out.” Aaron drew on equations from class to “figure out my power calculations” in setting up commercial building fire alarm systems. Across the interviews and the survey, students identified how math concepts they learned and problems they worked on related to real-life scenarios. In making these connections, they saw and appreciated the utility of math.

Building and translating a foundation in math

Regardless of students’ initial math foundations, their stories and survey responses evidenced that the contextualized math courses helped them form a solid basis that they could use and carry over to other program courses. Aaron said, “it definitely strengthened my grasp on math. I was never incredibly skilled at manipulating equations, and I definitely felt like I had gotten a much more solid grasp on it after that class.” Nick also found the applied electronic math class helped in “laying the foundation . . . for the more involved stuff.” Alex said, “you really do use a lot of the things that you learn in the math class in your normal classes.” Contextualized math classes’ transferability served students well in both other courses and in their professions.

Situating contextualized math within broader education and goals

Although many of the students were unsure how math would fit into their programs and future goals – other than a requirement – their contextualized math courses showed them otherwise. Even though the students had diverse goals, the survey and interviews revealed that the math students learned in their contextualized courses filtered into all aspects of their broader education and careers. The courses often helped reinforce their education and career plans, seeing it as one piece toward the bigger picture. It was a “stepping-stone” as Aaron called it or “something you need to take before you move on” as Micah put it. Kevin could see the math at work in his current job, but also considered how he could situate it in his future education at the bachelor’s level and prospective line of work. Survey responses also confirmed student confidence in advancing toward goals in math, college, and beyond as a result of their contextualized math courses. The students were not only able to see how the contextualized math class fit into their broader educational and career goals, but it also represented a reaffirming experience for them, keeping them moving forward in their program and toward their aspirations.

Discussion

This study provides insight into community college students’ experiences in two contextualized math courses and how those experiences moved the students forward in math and beyond. Here, we segue into a deeper discussion situated within existing work and examine how the findings deepen our conceptualization of momentum through contextualization.

Our study reinforces contextualization as a promising and appealing option to consider for college-level math. Research has established the growing array of courses in which contextualization operates, from elective or basic skills math serving a variety of disciplines to technical programs offering math-based classes like welding and machine tool (e.g., Jenkins et al., 2009; Parker et al., 2018; Quarles & Davis, 2017; Skuratowicz et al., 2020; Wang, Sun et al., 2017; Yamada et al., 2018). Our findings reveal that contextualization enhances students’ learning experiences in additional areas, such as construction and remodeling and electrical engineering technology. Thus, contextualization can be used and benefit students across various courses, programs, and disciplines.

Focusing on our first research question on students' experiences in contextualized courses, our study aligned with Wang, Sun et al. (2017), in that students came away with positive views on math, including its utility and connections beyond the classroom. This led students toward a deeper understanding of and genuine appreciation for math (Wang, Sun et al., 2017). The students consistently noted their instructors diving into individual math problems to better understand the how and why aspects of engaging with math. In doing so, the students were able to see the purpose in the math they were learning and feel more confident and empowered in their math knowledge and skills. Instructors acted intentionally with the math exercises they incorporated into their classes, inviting students to find meaning in their learning (Johnson, 2002). Our findings further echoed how students came to "view math as applied, real-world problems, as opposed to abstract terms" (Wang, Sun et al., 2017, p. 429).

What is new is that our study participants did not express any fear or anxiety associated with math, which can be a prevalent feeling for community college students encountering math courses (e.g., Wang, Sun et al., 2017; Woodard & Burkett, 2005). The students noted an initial uncertainty about what to expect, often referencing prior experiences in terms of structure, format, and utility. Confidence in one's ability to do math was a sentiment that emerged from the students in our study, as some felt more or less confident from the onset, but as they progressed in their contextualized courses, their confidence grew. This finding may be reflective of the students coming in with a higher level of math preparation being enrolled in college-level math. It is possible that they might not have had as strong a fear of math as students in developmental math courses, who tend to have lower levels of math preparation and poor prior experiences. All the same, these students expressed transformative and clarifying experiences with math.

Reflecting on our second research question, our findings inform how we think about contextualization as momentum in the community college. Research using the momentum model has explored singular domains (e.g., Chan & Wang, 2018). Our study extends this work by illuminating the different ways all three domains operated, as well as how they intersected and informed one another within the context of math teaching and learning. For example, in the curricular domain of the momentum model (Wang, 2017), math can easily become a friction point preventing students from enrollment continuity. However, the contextualized courses did not present an obstacle for the students. Instead, all of the students indicated how smoothly their contextualized math course went, how it played into their course sequence, and that they were continuing on to other courses in their program.

In terms of the teaching and learning domain, it was clear that the students' experiences revealed several facets of cognitive momentum, which refers to the "thinking, understanding, and learning of the subject matter" (Wang, 2017, p. 284) they built throughout the contextualized math classes. Accumulating knowledge through the breaking down and building upon math concepts and content helped create a strong math foundation for the students within and beyond the course. The students consistently described their ability to grasp math subject matter and even translate it to other courses. Cognitive momentum was cultivated not only by the instructor, but also through other students in class through group work, allowing the students to process, understand, and communicate math concepts and solutions among one another.

For the motivational domain, the contextualized courses reaffirmed students' goals, thus boosting their aspirational momentum. The students were fairly clear about their educational and career goals beforehand, but as they progressed through the courses, they became more certain about their aspirations and achieving them. Moreover, the students exhibited growth mind-set as they experienced the contextualized math classes, going from self-perceptions of not being very strong in math to seeing themselves as successful in math and the workforce. Agentic momentum came to light as students were encouraged to individually and collectively work together to comprehend various math ideas and theories, and find answers to math problems.

We also extend prior work by observing intersections across domains. The students' experiences with group work in the contextualized math courses helped enhance cognitive momentum and agentic momentum. Within domains, we saw how the students' shift in growth mind-set increased confidence

in math and reinforced their aspirational momentum to continue on their intended educational and career paths. Altogether, contextualization presents a valuable approach to enrich community college students' experiences in math and build momentum across domains, thus maintaining forward motion through math, other courses, and beyond.

Implications and conclusion

Although contextualization in college-level math courses holds promise based on our findings, institutions may question the disciplinary areas appropriate and ripe for contextualization. In our study, the vocational math course was situated within the math department, whereas the applied electronic math course was tied to a technical department. This may suggest that contextualization not be applied in a narrow scope, as it can be useful across all types of courses and disciplines (National Council for Workforce Education & Jobs for the Future, 2010). In essence, contextualization should not be an isolated effort. Instead, it needs to be widespread and seen as valuable across program areas.

The faculty members in our study engaged in professional development with the purpose of and commitment to integrating contextualization into their course curricula. We recognize that faculty and curriculum development opportunities may not be available, especially given faculty's many roles and responsibilities (Eddy, 2005). A more practical entry point toward contextualization could involve smaller, incremental modifications, such as incorporating group work, presenting real-world and career-oriented problems, or making explicit connections between math concepts and other disciplinary knowledge and skills. Faculty can tailor these practices to what works best in their individual course contexts, content, and requirements.

As we look to additional research in this vein, future inquiry should investigate students' experiences in contextualized courses across other program areas and among larger student samples. Further study would examine students across gender and racial/ethnic groups, as their experiences may or may not differ. Next, research should integrate a longitudinal approach to study students' experiences in contextualized courses and how those experiences create momentum toward their longer-term outcomes. Also, future inquiry might consider exploring curricular momentum through course sequencing and enrollment intensity for a fuller picture of the impacts of contextualization. Transcript and administrative records would enhance research toward that end, as institutions can readily tap into and track this data over the course of students' enrollment and programs. Finally, faculty perspectives would lend insight into their experiences with related professional development and implementation, opportunities and challenges using this approach, how they assess students, among other facets, offering additional dimensions of this process toward a larger picture of contextualization as a viable approach to math teaching and learning.

As community colleges seek to improve math learning and success, contextualization has surfaced as a promising strategy to help students understand and master math. Our study offers valuable student perspectives in two contextualized math courses, which reinforces the potential of this approach and how such experiences build momentum along students' educational journey. With contextualization, math becomes "real-life math," as Alex put it, resulting in immense student learning and growth within and beyond math, leaving students "eager to learn more."

Note

1. For an extensive description of contextualization and its various approaches, see work by Baker et al. (2009), Perin (2011), and Wang, Sun et al. (2017).

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coding to honor and draw upon students' own voices within those stories. This coding strategy allowed us to build a foundation toward narratives of community college students' experiences with contextualization and related patterns that emerged. We coded each transcript separately and engaged in discussions upon completing transcripts to identify overlapping codes and notable differences and recalibrate as needed. Doing so enabled us to identify similarities and differences across narratives, develop categories, and reconcile variations in how we interpreted participants' stories. We incorporated field notes and survey data to deepen and explore any alignment or departure based on students' stories. Together, we converged upon common categories that honored the codes and stories. We engaged in thematic analysis (Riessman, 2008) to compare across narratives and arrive at themes. This iterative process ensured the themes reflected the research questions and the students' stories.

When organizing students' stories, we relied on a combination of three-dimensional narrative space (Clandinin & Connelly, 2000) and plot structure (Yussen & Ozcan, 1996). The three-dimensional narrative space helped us understand students' narratives based on three components: interaction, continuity, and situation. Interaction allowed us to examine participants' personal and social lenses, noting how they described their internal and interpersonal experiences. Continuity entailed arranging participants' descriptions of their stories into past, present, or future. Situation entailed the place(s) with respect to physical spaces or those within students' stories. The plot structure further illuminated five essential components of each participant's narrative: characters, setting, problem, actions, and resolution. This process allowed us to see each student's experience as a unique story with various angles, contexts, and turning points. See Figure 2 for an illustrative excerpt of the narrative organization process.

Trustworthiness

We triangulated qualitative data across several sources, including interviews, field notes and survey data, to afford rich and complementary findings (Miles et al., 2019) and cross-checking (Merriam & Tisdell, 2016). We also engaged in peer review (Lincoln & Guba, 1985), which established an external

Characters		Setting		Problem		Actions		Resolution	
- Interviewers - Interviewee - Instructor - Classmates - Brother - Father		- Two-year college - Prior four-year institution - Construction and modeling program - Vocational math class - Work sites		- Not performing well at previous college - Finding a major that fits - Not seeing himself as good in math - Math teaching and learning too quick and questioning relevance		- Transferred to two-year college - Found fitting program in construction and remodeling - Took vocational math course - Engaged in internships		- Feels he can do math - Graduating program - Entering workforce - Clear work goals to progress in his line of work	

Interaction		Continuity			Situation/Place
Personal	Social	Past	Present	Future	
Reserved	Talked with other students about taking vocational math class Instructor teaching students Students work on assignments together Students helped one another in class	High school math was a challenge	Recently obtained construction job; working there part-time and full-time once semester ends	Hopes to obtain a managerial position in construction job	Lounge area in main building
Thoughtful/reflective		Failed math class last year			Vocational math course classroom
Did not feel like a four-year (bachelor's) plan was for him		Previously attended four-year college	Taking fundamentals 2 class related to building and carpentry		Workshop
Viewed himself as bad in math, not a math person		Was a baseball player and communication/political science major	Taking remodeling class		House
Believes material in vocational math class is useful in other classes		Took vocational math class			
Likes to build things		Construction internships			Construction sites
More motivated and confident in math					

Figure 2. Example segments of the narrative development process.

check (Lincoln & Guba, 1985) and probing for any biases in the data analysis process (Shenton, 2004). This interrogation of our methods, analysis, and findings also ensured the credibility of the study. Finally, we aimed for confirmability, which enables future researchers to have a clear sense of the steps we took. We carefully outlined and recorded our methods and analytical procedures along the way, noting assumptions and thought processes to illustrate how they shaped our interpretations (Miles et al., 2019) and emergent findings.

Limitations

We recognize that all six participants are men, which may present a more narrowed experience of contextualization. While this was not the study's intentional population of focus, we acknowledge that this may inhibit a well-rounded portrayal of student experiences with contextualization. At the same time, the contextualized classes consisted of almost, if not all, men, which is characteristic of technical education programs (Lester, 2010). We also examined one two-year college in a Midwest state. Nonetheless, the rich narratives and description offered through our research design (Miles et al., 2019) and student voices allow transferability (Merriam & Tisdell, 2016) to other colleges with similar efforts, programs, and students.

Results

In this section, we present narratives detailing students' experiences in contextualized math courses, followed by the culminating thematic analysis based on the students' stories.

Aaron

Aaron started at TLC in the fall of 2017 after seven years of working as an electrician. Pursuing a career in electrical engineering, he enrolled in the applied electronic math course upon having positive interactions with the instructor in other contexts. Aaron used math every day, but the "guts of electronics" was a different realm for him, including the math involved.

As a "hands-on learner," Aaron valued his instructor's approach of deconstructing problems. The instructor then "would build you back up" by indicating, "This is the truest facts of what we have . . . and this is how we can start working with it, building on it, and then ultimately reach our solution." For Aaron, this process resulted in an "aha moment instantaneously and it was just clicking with me right away. I was understanding it."

While initially having no expectations of the class, he resonated with its format of alternating between lectures and discussions. He also valued the "crystal clear" directions from his instructor to know what to anticipate each week:

Anyone who takes the five minutes and read "Hey, these are the expectations, this is what you're gonna learn, this is what you're gonna do," they should really have no problem going in there. And on the first day it's "Okay, I'm ready to learn. I'm ready. I know what I'm getting into."

Since the course allowed students to process math independently and at their own pace, Aaron felt confident "to work ahead a little bit" and reviewed upcoming class units in advance to "see what the next section is going to be about." He said, "I could really just take my time on everything and figure it out at my own pace." Aaron added, "I definitely felt like I had gotten a much more solid grasp on [manipulating equations] after that class."

In his current job, Aaron operates with commercial building fire alarm systems. He found class problems on determining voltage to be helpful, a stark contrast to his other classes where he did not see clear connections between course problems and his job responsibilities. Aaron said he "would definitely be using the equations that we learned about in that class." He elaborated on the course reaffirming his goals:

[The math course has] really kind of strengthened my decision to continue with it and keep moving forward with it. . . . It gave me that little taste of “This is what it will be like,” and I was like, “That’s what I want. That’s why I want to keep moving forward.”

Alex

As a student athlete playing baseball, Alex began his college journey at a four-year institution: “I was a communication and political science major, and did not do too well there, kind of got into the whole like college freshman thing, had too much fun.” His parents and brother all had a bachelor’s degree or higher. Although the four-year plan was expected, Alex found it was not for him. Upon dropping out, he visited TLC, which he toured before, and immediately identified his passion: construction and remodeling. He “picked the major in five minutes, and then I just fell in love with that, right from the start, and so here I am.”

Alex’s past math experiences contributed to his skepticism of vocational math:

I really was bad at math. I actually failed my math class last year. Um, and just because I’ve never really been a math person, but it made me realize that I can do math if it’s involved in the right topic, like I really enjoyed building things, and if you involve it with that, then I would enjoy that math as well.

But the contextualized course he took was different: “I’ve always known how to do like the area and perimeter and all that stuff, but he [instructor] just kind of like put it back in your head.”

During each class, Alex’s instructor composed “a set to-do list right on the board,” allowing him to draw clear expectations for each lesson. Alex also appreciated how his instructor recognized students’ varying abilities and adjusted the pacing accordingly:

He definitely did have times where he was like, “Alright, we should probably slow this down. Some of you guys are not getting this.” So he would slow it down . . . wait till everybody or the vast majority of everybody really just had it honed in, and the remainder of the people who didn’t have it down, they would get help from the other students.

Unlike previous classes in which he did not find the utility of math, Alex found the real-life scenarios that his instructor incorporated to be very helpful. He summed this up: “I never really saw how to use them [math concepts] in real life, but this is legitimately my real-life math that I use on a day-to-day basis . . . now that I know why I’m doing it, I’m eager to learn more.”

Not only did the vocational math class lay crucial groundwork in math for Alex, but he was able to take what he learned and transfer it to his other classes: “I would go from my math class immediately to my other class, and be like, ‘Alright, I just did this.’ And I knew how to do it right away.” He detailed the class impact:

I never learned more in my life in such a short period of time . . . and so it’s just like crazy learning so much and not really feeling like I’ve been learning that much . . . And your math classes are involved in your normal class. Everything is just integrated.

Flynn

Flynn was finishing a construction and remodeling program with hopes of entering into an apprenticeship. He had taken algebra and trigonometry in high school: “I understood math. I just never wanted to be – or excel in math . . . I just was never the best in math.” He figured that taking the vocational math course would be another “bullshit math class.” It was far from it.

Instead, Flynn was emphatic about the course content having great value in his program and future career. The course helped in “making sense of doing math in the field” as he took flooring measurements for a house he was involved in renovating. Flynn noted the incremental process of putting math

information together toward a solution and greater comprehension of math when he was “reading the tape measure, took the math, put it on paper, and you drew it out and figured everything out from there.”

Additionally, Flynn found the textbook to be “very easy to understand. Everything was right there, right in front of you, and the scenarios were in the book.” While Flynn said he would rather be building than solving math problems, the course examples helped him “understand why I was doing the math.” Flynn affirmed that the math foundation was necessary because “you’re doing math every single day in the classrooms that we are in.” He expressed valuing vocational math in further empowering him to recognize, understand, and apply math in the field.

Kevin

A fascination with electronics pushed Kevin toward electrical engineering and aspirations of a bachelor’s degree. He considered himself not “terribly financially stable,” leading him to enroll in the electrical engineering technology program at TLC so he could affordably fulfill his goals. Although Kevin knew what he wanted to do, he was not entirely sure the applied electronic math course would connect with him and move him along toward his goals: “I took a calculus course in high school, I took trig, but it was so broad, and it didn’t like help me determine a career out of it.” He was uncertain, but he went ahead and took the course.

Kevin was pleasantly surprised by the course. It was nothing like the math courses he took before. It was very focused, showing him how to “use this part of trig and this part of calc, and learn how to analyze this.” The course drew upon all kinds of areas and levels of math but was very specific in terms of where to use it. There was also a breaking down of math and building up of math comprehension: “It was like a step-by-step process on how to take all of these past steps and put it into the next step, and it would lead to like a bigger, bigger congregation of knowledge.” Kevin appreciated the scaffolding of math.

Another enjoyable surprise was that the class involved a lot of group work, which helped Kevin see and understand math in different ways. Students could work in groups to find solutions to math problems, and the instructor integrated regular opportunities for students to explain math concepts and answers to one another. This made a huge difference to Kevin during a review for an upcoming exam. He was struggling with a particular theorem, Norton’s Theorem:

... for some reason, I wasn’t just understanding the concept. And one of my friends drew the diagram on the board and was like, “Okay, you have to look at it from this way, and like move this here.” And then I was like, “Oh, that’s perfect. I get it.” And so that was like the day of the exam, which was very helpful, because I think I got this question right.

While Kevin found collaborating with students to be a helpful and encouraging process, he also valued the ability to work through course materials on his own if needed. His instructor provided enough resources and support to facilitate these different ways of working through math.

Kevin’s positive experiences in the math class changed how he saw himself as a math learner: “In high school, I thought I was like decent at math. I know I wasn’t the best.” The course helped “bring that knowledge” along, growing Kevin’s confidence and ability to see a path forward. The applied electronic math class aligned with and confirmed his future educational plans and career:

I’m really passionate about electrical engineering in that class, like “Oh, I get this, everything’s clicking,” and I was able to just excel in that course and other courses, and that reaffirmed what I want to do as a career.

After Kevin finished the course, he obtained a job at an electronic engineering company. In his work, he could see the math that he learned emerging on a regular basis: “So I can like use what I’ve learned ... and kind of determine what could have gone wrong.” He added, “[the course] really [helped] with my current job, because I can ... apply it.” Through his course experiences, Kevin felt he could better situate math in his future education and prospective line of work.

Micah

Micah started at another two-year institution in a different state in pursuit of transfer and becoming an electrical engineer. At that college, he enrolled in several math courses, or “all of those hard classes,” Micah called them. He took Calculus 1, 2, and 3, as well as calculus in high school. Micah switched to TLC to become an electronic technician instead. He felt the change would align with his interest in electronics. Plus, “it opens many doors, like, I can start my own business, or join a job that primarily fixes electronics, or join a company that makes a specific electronic for a specific client . . . It’s so many doors that I could just choose from.”

Micah enrolled in the applied electronic math class, but “didn’t have any expectations. More like that’s a class I have to take, and then finish. But when I took the class, it’s really not that complicated.” In the past, there were so many equations, and it was unclear where and when he would have to use them. This math class was clear. Everything made sense. Micah mentioned that “the structure is very simple, like you’re gonna learn this particular material.”

When laying out the math, the instructor would break it down, making it “very simple.” Even if students had little math knowledge, Micah was confident any student could pass it. This class was also flexible, allowing him to access course materials online and review them on his own as needed. He found that there were many occasions in which he collaborated with other students: “we joined groups and we’d try to tackle problems.” There was often an exchange of ideas and advice among the students to solve math problems. Micah described the math as “everything is useful.” He was able to identify how the concepts and the problems related to real-life scenarios and work. Everything he learned would be used “in the long run.”

Micah thought about his next steps in his program. He saw the applied electronic math class as something “you need to take before you move on” in general and “before you move on with super advanced stuff.” It was one piece toward higher level coursework and his degree and career goals. The course helped him transition seamlessly into other program courses. Micah was hoping to finish his program next year, “if everything goes right.” He passed the math class and was one step closer to another course, his degree, and endless job opportunities.

Nick

An aspiring electronic engineer, Nick had taken math in the past, but he did not always finish the courses. He tried calculus, but it was a struggle. Nick took a smattering of algebra courses, which went better. He was used to lectures, taking notes, and figuring math out on his own. Going into the applied electronic math course, he did not have many expectations, other than more math-based equations. However, Nick found that “the class is pretty straightforward . . . everything was laid out . . . You knew what to expect . . . and what was expected.” The class not only focused on concepts, but dug into math to understand “how it worked and the ideas behind it.” This approach resonated with Nick and made the math come easier for him.

As Nick progressed in the course, he was able to make connections between what he learned and the electronics field, which made him appreciate the utility of math. He could see “how it relates to all the electronics and the principles behind that stuff.” Nick added, “it’s definitely more helpful learning about it and actually seeing it in real life and seeing how it’s used.” Other than connecting math to electronics, he could see the class fitting into other aspects of his program: “[it] just kind of give[s] you a better understanding of some of the ideas early on in the program . . . laying the foundation and . . . getting you ready for the more involved stuff.”

Later on, Nick transitioned into a new job testing and inspecting circuit boards at an engineering company during his program. The math course came into play in his work, “figuring out how they [circuit boards] work or why they don’t work, and you just kind of learn. I’d say troubleshooting has

been very helpful.” Looking to the future, Nick would like to transfer to a four-year institution to obtain his bachelor’s degree in electronic engineering. Although he is not quite sure when he plans to go back, his math class helped pave the way toward that goal.

Looking across the narratives: Thematic analysis

Our thematic analysis revealed six themes. We arranged the themes based on our research questions. The first three reflected the first question about students’ experiences in the contextualized math courses. The latter three spoke to how students’ experiences shaped momentum toward their math, educational, and career success. We describe these themes below.

Making it “crystal clear”: Setting expectations and paving a clear learning path in math

Many students’ stories presented a stark contrast between prior math experiences and the contextualized math courses. Students tended to refer back to high school, where instructors often did not provide a clear road map of what they would learn and how it connected to different concepts. As a result, students had little to no expectations of what to anticipate with the contextualized math course, other than it could be similar to past experiences. However, as students began these courses, they found them to be clear and simple. Micah mentioned that “the structure is very simple, like you’re gonna learn this particular material.” Making everything clear, from the beginning of the course and throughout, positively shaped students’ contextualized course experiences, as reported in the survey and interviews. Students were at ease knowing what was expected of them and what they would be learning every step of the way.

Breaking it down: Digging into and building upon math content and knowledge

Students’ narratives revealed the breaking down of math as a common experience in their contextualized math classes. This breaking down of math problems was followed by a building up of knowledge and understanding of math. Aaron discussed this process: “She [the instructor] would break it all the way down to the bare bones of the equation.” His instructor would work with students to identify the information in the problem and how they could work with it and build on it toward the solution. Students’ survey responses reinforced this frequent process of figuring out what they knew, what they needed to know, and how to seek additional information to solve math problems. Kevin similarly mentioned the building up of math as “a step-by-step process . . . [that] would lead to like a bigger, bigger congregation of knowledge.” It was not about how fast or slow an instructor went through math concepts or problems; it was about depth. Digging in and doing math in an in-depth, scaffolded way was a dominant experience for these students, bringing them along toward a better understanding of and appreciation for math.

Dividing and conquering: Individual and group work dynamics

Students often noted an interplay between group and individual work. Although the instructors were there to facilitate the learning process, they provided ample time for students to both interact with one another or soak in math lessons on their own. Group work gave students the chance to work together toward solutions to math problems and learn from one another. Nick highlighted its benefits: “. . . if someone was struggling, you could kind of teach them, which was helpful, because it’s like re-emphasizing it in your head, and re-learning it, and then teaching someone else.” This regular peer teaching and learning through group work, as noted through the interviews and survey, helped students see different ways to solve math problems and reinforce concepts when teaching one another. Conversely, students also recounted moments when they could learn math independently and at their own pace. Students could process what they learned and figure out problems, but they could still reunite to discuss solutions. Individual and group work both served as important and informative spaces to further students’ understanding of math.

“Everything is useful”: Discovering and recognizing the utility of math

Students’ stories exposed prior experiences in which math meant very little to them. Through the contextualized courses, the students found parallels between the math content and concepts they learned, and how they served their current or future industry knowledge. Flynn made sense of math as he worked on building a house in his program: “You had the hands-on math . . . reading the tape measure . . . put it on paper . . . drew it out and figured everything out.” Aaron drew on equations from class to “figure out my power calculations” in setting up commercial building fire alarm systems. Across the interviews and the survey, students identified how math concepts they learned and problems they worked on related to real-life scenarios. In making these connections, they saw and appreciated the utility of math.

Building and translating a foundation in math

Regardless of students’ initial math foundations, their stories and survey responses evidenced that the contextualized math courses helped them form a solid basis that they could use and carry over to other program courses. Aaron said, “it definitely strengthened my grasp on math. I was never incredibly skilled at manipulating equations, and I definitely felt like I had gotten a much more solid grasp on it after that class.” Nick also found the applied electronic math class helped in “laying the foundation . . . for the more involved stuff.” Alex said, “you really do use a lot of the things that you learn in the math class in your normal classes.” Contextualized math classes’ transferability served students well in both other courses and in their professions.

Situating contextualized math within broader education and goals

Although many of the students were unsure how math would fit into their programs and future goals – other than a requirement – their contextualized math courses showed them otherwise. Even though the students had diverse goals, the survey and interviews revealed that the math students learned in their contextualized courses filtered into all aspects of their broader education and careers. The courses often helped reinforce their education and career plans, seeing it as one piece toward the bigger picture. It was a “stepping-stone” as Aaron called it or “something you need to take before you move on” as Micah put it. Kevin could see the math at work in his current job, but also considered how he could situate it in his future education at the bachelor’s level and prospective line of work. Survey responses also confirmed student confidence in advancing toward goals in math, college, and beyond as a result of their contextualized math courses. The students were not only able to see how the contextualized math class fit into their broader educational and career goals, but it also represented a reaffirming experience for them, keeping them moving forward in their program and toward their aspirations.

Discussion

This study provides insight into community college students’ experiences in two contextualized math courses and how those experiences moved the students forward in math and beyond. Here, we segue into a deeper discussion situated within existing work and examine how the findings deepen our conceptualization of momentum through contextualization.

Our study reinforces contextualization as a promising and appealing option to consider for college-level math. Research has established the growing array of courses in which contextualization operates, from elective or basic skills math serving a variety of disciplines to technical programs offering math-based classes like welding and machine tool (e.g., Jenkins et al., 2009; Parker et al., 2018; Quarles & Davis, 2017; Skuratowicz et al., 2020; Wang, Sun et al., 2017; Yamada et al., 2018). Our findings reveal that contextualization enhances students’ learning experiences in additional areas, such as construction and remodeling and electrical engineering technology. Thus, contextualization can be used and benefit students across various courses, programs, and disciplines.

in math and reinforced their aspirational momentum to continue on their intended educational and career paths. Altogether, contextualization presents a valuable approach to enrich community college students' experiences in math and build momentum across domains, thus maintaining forward motion through math, other courses, and beyond.

Implications and conclusion

Although contextualization in college-level math courses holds promise based on our findings, institutions may question the disciplinary areas appropriate and ripe for contextualization. In our study, the vocational math course was situated within the math department, whereas the applied electronic math course was tied to a technical department. This may suggest that contextualization not be applied in a narrow scope, as it can be useful across all types of courses and disciplines (National Council for Workforce Education & Jobs for the Future, 2010). In essence, contextualization should not be an isolated effort. Instead, it needs to be widespread and seen as valuable across program areas.

The faculty members in our study engaged in professional development with the purpose of and commitment to integrating contextualization into their course curricula. We recognize that faculty and curriculum development opportunities may not be available, especially given faculty's many roles and responsibilities (Eddy, 2005). A more practical entry point toward contextualization could involve smaller, incremental modifications, such as incorporating group work, presenting real-world and career-oriented problems, or making explicit connections between math concepts and other disciplinary knowledge and skills. Faculty can tailor these practices to what works best in their individual course contexts, content, and requirements.

As we look to additional research in this vein, future inquiry should investigate students' experiences in contextualized courses across other program areas and among larger student samples. Further study would examine students across gender and racial/ethnic groups, as their experiences may or may not differ. Next, research should integrate a longitudinal approach to study students' experiences in contextualized courses and how those experiences create momentum toward their longer-term outcomes. Also, future inquiry might consider exploring curricular momentum through course sequencing and enrollment intensity for a fuller picture of the impacts of contextualization. Transcript and administrative records would enhance research toward that end, as institutions can readily tap into and track this data over the course of students' enrollment and programs. Finally, faculty perspectives would lend insight into their experiences with related professional development and implementation, opportunities and challenges using this approach, how they assess students, among other facets, offering additional dimensions of this process toward a larger picture of contextualization as a viable approach to math teaching and learning.

As community colleges seek to improve math learning and success, contextualization has surfaced as a promising strategy to help students understand and master math. Our study offers valuable student perspectives in two contextualized math courses, which reinforces the potential of this approach and how such experiences build momentum along students' educational journey. With contextualization, math becomes "real-life math," as Alex put it, resulting in immense student learning and growth within and beyond math, leaving students "eager to learn more."

Note

1. For an extensive description of contextualization and its various approaches, see work by Baker et al. (2009), Perin (2011), and Wang, Sun et al. (2017).

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