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Promoting Latinx adolescents' math motivation through competence support: Culturally responsive practices in an afterschool program context

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ABSTRACT

Early adolescence is an important period for students' math motivational beliefs. This explanatory sequential mixed methods study examined middle school students' experiences in a university-based math afterschool program serving predominantly underprivileged Latinx adolescents. First, utilizing quantitative pre- and post-survey data ($N = 129$), we found that the support adolescents received in the program for their competence needs positively predicted changes in their math motivational beliefs (i.e., math ability self-concepts and subjective task-values) over one academic year. In our follow-up analysis of qualitative interview data ($N = 28$), we examined specifically how mentors in the program supported adolescents' competence needs. The findings highlight culturally responsive practices - including helping adolescents leverage their funds of knowledge as well as various strategies and perspectives for problem-solving during math activities - that afterschool programs and mentors can utilize to create supportive learning environments for competence needs that help to promote adolescents' math motivational beliefs.

1. Introduction

Math proficiency is necessary to succeed in math as well as other science, technology, engineering, and math (STEM) pursuits, but proficiency alone is not enough as many highly capable individuals become disengaged and eventually leave all STEM domains (Andersen & Ward, 2014; Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Watt et al., 2017). Aside from proficiency, students who are most likely to pursue STEM are those who believe they are good at it and believe it is interesting and important (Eccles & Wigfield, 2020; Simpkins, Davis-Kean, & Eccles, 2005). Unfortunately, motivational beliefs in math and science typically decline over time (e.g. Jacobs et al., 2002; Osborne, Simon, & Collins, 2003), particularly during early adolescence (Chittum, Jones, Akalin, & Schram, 2017; Tai, Liu, Maltese, & Fan, 2006). The middle school years are a time when skills are being learned and when students' perceptions about their competencies become solidified, which form the basis for personal identities and future goals (Erikson, 1993). Building a solid foundation in students' math skills and motivational beliefs during middle school can help them successfully weather the developmental challenges they will face in high school. Contexts during middle school that continue to support their interests and provide opportunities for their continued mastery and growth will help provide that solid foundation (Renninger & Hidi, 2016).

Organized afterschool programs are settings that offer dynamic opportunities where students can engage in opportunities for skill development that foster their motivational beliefs in STEM (National Research Council, 2015; Vandell, Larson, Mahoney, & Watts, 2015). Importantly, mentoring, whereby adult staff serve as role models for and support students, represents a key relational mechanism through which programs provide a supportive environment for students' motivational beliefs in math (Vance, 2018; Smith, McGovern, Larson, Hillaker, & Peck, 2016; Yu et al., 2021). Though we know that adults' support of students' motivational beliefs is helpful, we know less about the developmental supports and culturally responsive practices mentors can use to support students, which is vital information for training and continuous quality improvement.

Utilizing an explanatory sequential mixed methods research design (Creswell & Clark, 2017), this study first quantitatively tested the

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association between Latinx middle school students' perceptions of support for their competence, autonomy, and relatedness needs in a math afterschool enrichment program and the changes in their math motivational beliefs (i.e., math ability self-concepts and subjective task-values) over one academic year. These findings framed a qualitative analysis of in-depth interviews to identify and understand practices that mentors used to provide support for adolescents' need for competence.

1.1. Supporting adolescents' math motivational beliefs for minoritized adolescents

A growing body of research suggests that students' math motivational beliefs have implications for a variety of STEM outcomes during adolescence and into adulthood, yet we know less about the ways to support their positive motivational development in afterschool activities (Tai et al., 2006; Chittum et al., 2017). Situated Expectancy Value Theory (SEVT; Eccles & Wigfield, 2020) stresses two components of motivational beliefs: individuals' beliefs about their abilities in a specific task (i.e., ability self-concept) and their value of a task (i.e., subjective task-value). Ability self-concept beliefs comprise mental representations of students' own abilities, whereas subjective task-value beliefs include one's interest and perception of the task's importance. According to the theory, support from key adult socializers, such as parents, teachers, and mentors, predicts students' perceptions of their academic experiences, which, in turn, influence their motivational beliefs (Eccles & Wigfield, 2020).

Like SEVT, Self-Determination Theory (SDT) suggests that the support students receive in their various contexts influences their motivational beliefs (Hattie, Hodis, & Kang, 2020; Ryan & Deci, 2020). SDT, however, argues that contextual support will be most influential if that support addresses students' three fundamental psychological needs for competence, relatedness, and autonomy (Niemiec & Ryan, 2009; Ryan & Deci, 2020). Broadly, the need for competence refers to the need to feel skilled and capable of overcoming challenges. The need for relatedness refers to the need to feel a sense of closeness and connectedness with others. The need for autonomy refers to the need to feel agentic or decisive in one's actions. Contexts that support students' needs for competence, relatedness, and autonomy should promote students' motivational beliefs (Ryan & Deci, 2020).

SEVT and SDT are helpful frameworks for examining social processes that lead to the development of motivational beliefs. However, unlike SEVT which focuses more on how students understand and interpret their own performance and the many messages they receive from different adult socializers regarding their activity participation and performance, SDT highlights three key supports of an educational context (i.e., support for competence, autonomy and relatedness needs) that can foster and promote the development of motivational beliefs (Niemiec & Ryan, 2009). Integrating the tenets of SEVT and SDT, the current study extends prior research (see Wigfield, Eccles, Fredricks, Simpkins, Roeser, & Schiefele, 2015 for a review) to test if support for competence, autonomy and relatedness needs in an afterschool math enrichment program predict changes in students' math motivational beliefs and to describe the specific ways adult socializers provide support in these settings. In doing so, we aim to contribute to the education motivation literature by highlighting what is supportive for promoting students' motivational beliefs in math and identifying concrete practices that adult socializers can use to more effectively support students.

In the current study, although we consider all three types of support broadly, we take a closer look with qualitative data at the mentorship processes that support students' need for competence. In their seminal publication on SDT, Deci and Ryan (1985) argued that the need for competence is a major reason why individuals seek out optimal stimulation and challenging activities, and that intrinsic motivation (activities done for their own sake) is maintained only when individuals feel competent. In addition, the concept of competence is an important aspect of other prominent motivation theories including SEVT (Eccles & Wigfield, 2020), self-efficacy theory (Bandura, 1977) and achievement goal theory (Elliot & Dweck, 2013). For example, research related to SEVT, the other framework used to guide the current study, has highlighted how students' motivation may be enhanced as they experience mastery of tasks and develop ability self-concept beliefs (Eccles & Wigfield, 2020). Understanding the processes that facilitate or undermine the development of competence has important implications for programs, like the one in this study, where one central goal is to build competencies in a specific domain.

Given the well-documented disparities in STEM, there is an important need to consider these processes for racially and ethnically minoritized adolescents and the role that culture and culturally responsive practices play to promote students' math motivational beliefs. Culture is an integral and inseparable part of youth development (Paris & Alim, 2017; Vélez-Agosto, Soto-Crespo, Vizcarrondo-Oppenheimer, Vega-Molina, & García Coll, 2017) and thus has important implications for making math learning more relevant to and effective for racially and ethnically minoritized students (Gay, 2010). Specific to students' motivational beliefs, research demonstrates the value of culturally responsive practices, including designing an environment where cultural differences are recognized and valued, in supporting different facets of students' learning experiences and motivation development (see Kumar, Zusho, & Bondie, 2018 for an integrative review). Unfortunately, although more recent attention has been paid to culturally responsive practices in afterschool programs, including STEM programs (National Research Council, 2015), the field lacks evidence and clarity with respect to the specific ways culturally responsive practices can promote students' motivational beliefs in math in these settings. Understanding the nuances of culturally responsive practices, including identifying which practices are used by staff and which may matter most to students, can help programs better meet and address adolescents' diverse needs and positive development (Simpkins, Riggs, Ngo, Vest Ettekal, & Okamoto, 2017; Williams & Deutsch, 2016).

1.2. Culturally responsive STEM afterschool programs for Latinx students

Recognizing the importance of culturally responsive practices, scholars (e.g., Simpkins et al., 2017; Erbstein & Fabionar, 2019; Williams & Deutsch, 2016) have argued the need to examine how the features of high-quality afterschool programs (Eccles & Gootman, 2002) can be implemented in ways that are culturally responsive and that promote positive student outcomes. Among a small yet growing body of literature, research suggests that participating in STEM afterschool programs can positively influence students' motivational beliefs in math and STEM more broadly (Allen et al., 2019; Krishnamurthi, Ballard, & Noam, 2014). Importantly, research has also documented that the positive effects of program participation can also buffer against the declines in adolescents' math motivational beliefs, which may manifest as no changes over time (Jacobs et al., 2002). In line with a culturally responsive approach (Simpkins et al., 2017), prior studies have proposed that part of the reason we see positive effects can be attributed to these settings' youth-centered, flexible, and interactive nature geared towards skill development through engaging activities compared to typical STEM classes in schools (Hiller & Kitsantas, 2014; National Research Council, 2015; Sahin, Ayar, & Adiguzel, 2014; Vance, 2018). Moreover, programs provide opportunities for students to engage in youth-adult mentorship experiences which can positively influence students' engagement in programs, development of skills, and motivational beliefs in math (Allen et al, 2019; Chittum et al., 2017; Kuperminc et al., 2019; Vance, 2018). These aspects of afterschool programs point to how these settings can help to support students' developmental needs during early adolescence, a period of development in which students begin to engage in progressively complex and instigative activities and thus may need more adult support and scaffolding (Eccles & Gootman, 2002; Yu & Deutsch, 2021).

The affordances of STEM afterschool programs, including opportunities for mentorship experiences, might be particularly helpful for Latinx students given the structural barriers they face in schools that limit their opportunities to pursue STEM (Scott & Martin, 2014). Although Latinx individuals account for 18% of the U.S. population and are projected to account for more than half of the school-aged individuals in the U.S. by 2050, they only make up 5% of all math scientists and physical scientists in the U.S. (Fry & Gonzales, 2008; National Science Foundation 2019). Latinx youth also report lower ability self-concepts in STEM compared to their White and Asian American peers, although there are mixed results for whether such differences are evident for subjective task-values (e.g., Andersen & Ward, 2014; Bouchey & Harter, 2005; Brown & Leaper, 2010; Simpkins, Price, & Garcia, 2015).

STEM afterschool programs are successful in engaging and retaining large numbers of students from Latinx communities in STEM (Krishnamurthi et al., 2014; National Research Council, 2015), suggesting that they could be leveraged to counter the racial/ethnic disparities in STEM. In addition to supporting students' developmental needs during early adolescence, scholars have theorized that to optimize youth outcomes, programs and mentors must be culturally responsive to youth's lives outside of the program context and their cultural backgrounds (e.g., Erbstein & Fabionar, 2019; Simpkins et al., 2017; Williams & Deutsch, 2016). Unfortunately, programs and mentors often face a range of challenges implementing culturally responsive practices including effectively engaging students and navigating cultural differences and culture-related incidences (Ma, Yu, Soto-Lara, & Simpkins, 2020; Gutiérrez, Larson, Raffaelli, Fernandez, & Guzman, 2017; Larson & Walker, 2010). Considering these potential challenges, there is a need for research that unpacks the situative processes underlying culturally responsive practices in order to inform concrete practices for the field.

Leveraging the concept of "funds of knowledge," for example, originally developed by Vélez-Ibáñez and Greenberg (1992) in the context of US-Mexican households and extended by Moll, Amanti, Neff, and Gonzalez (1992) to education, provides a powerful way that mentors can connect Latinx students' cultural knowledge and familial experiences to their academic learning. Leveraging Latinx students' funds of knowledge in afterschool programs represent culturally responsive practices that can have strong implications for promoting their engagement and motivation in math (Simpkins et al., 2017; Yu et al., 2021).

Answering recent calls in the field of motivation and educational psychology to undertake more research with diverse and understudied populations including Latinx youth and out-of-school contexts (e.g., Schunk & DiBenedetto, 2020; Wigfield & Koenka, 2020), and to embed a more situative and cultural approach to studies of motivation (Eccles & Wigfield, 2020; Nolen, 2020), our study calls attention to Latinx students' developmental experiences in afterschool programs, the role of culturally responsive practices, and the potential impact of these factors on students' developing math motivational beliefs during early adolescence.

2. Current study

Utilizing explanatory sequential mixed methods research design (Creswell & Clark, 2017), the current study examined Latinx middle school students' experiences in a math afterschool program. First, utilizing quantitative methods to analyze pre- and post-program survey data, we asked:

> To what extent did adolescents' perceptions of support for competence, autonomy and relatedness needs in the program predict their post-program math ability self-concepts and subjective task-values, over and above their pre-program levels of motivational beliefs?

The quantitative analysis included all three types of support identified by SDT to provide a broad overview. Though SDT notes that all three types of support are necessary to promote motivation, each type of support is complex and requires more in-depth examination.

Toward this end, the second part of our study drew on qualitative methods to analyze in-depth interviews and focused on Latinx adolescents' perceptions of the ways their mentors provided competence support in the program and the role of these practices in promoting their motivational beliefs in math. The following research questions guided our qualitative methods:

> What competence-related skills did Latinx adolescents report developing during math activities in the program?
> How did mentors help support the learning process related to adolescents' development and practice of these skills?
> How did these skills and related mentoring practices help promote adolescents' math motivational beliefs?

By utilizing this multistep, mixed methods process, our study aligns with a situative approach and allows for a deeper and richer sense of the developmental and cultural experiences of the Latinx adolescents in the program and the processes by which they form their motivational beliefs in math (Eccles & Wigfield, 2020; Nolen, 2020).

2.1. The study context

The study context was Math CEO, a math afterschool program at the University of California, Irvine that serves students from three local middle schools in Southern California. Over 90% of the students across these schools were Latinx and over 95% were free/reduced school lunch recipients. Approximately 24% of the students at these schools met or exceeded the state math proficiency standards (compared to the California state average of 39%). With the help of teachers in the middle schools, students were recruited and selected into the program based on an application process that took into account who teachers believed could benefit most from the program. As a result, a large proportion of participants in the program included students who struggled with math, but there were also high-performing students looking for extra math enrichment beyond what local schools could offer. College students were recruited as mentors each academic year. Based on demographic data collected during the time of this study (2018–2019), approximately 55% percent of mentors were Asian and/or Pacific Islander, 25% Latinx, 14% White and 14% mixed race/ethnicity or other. Over 50% of mentors were federal student aid recipients and over 40% of all mentors were first-generation college students.

Middle school students were provided bus transportation directly from their schools to the program to participate in 2-hour weekly math enrichment sessions, STEM-focused field trips, and college-prep activities. As part of the program, mentors facilitated weekly math enrichment sessions with adolescents. Adolescents were separated into groups of 6–10 with 2–3 mentors. The weekly program sessions were collaborative in nature and often required adolescents and mentors to work together to accomplish group math activities. These activities were designed to go beyond focusing on procedures or applications, allow multiple solution approaches, and encourage the development of sense making and tolerance of ambiguity through productive struggle. The program used manipulatives, diagrams and visual aids to provide adolescents with flexible entry points in the exploration of challenging problems. By encouraging collaborative learning, the activities sought to promote verbal communication between the mentors and adolescents, and among the adolescents themselves. One of the key goals of the program was to help students use their own ideas and explanations from others to develop a durable understanding of math. The math topics covered in the meetings varied, and included percentages, ratios and proportions, patterns, geometry, probability, modular arithmetic, estimations, equations and inequalities, mental math, fractals, and pentominos. A common feature of all the activities (independent of the topics covered) was the emphasis on explaining the thought process and the reasoning behind a solution, rather than on the answer itself.

Table 1
Descriptive statistics of quantitative and qualitative samples.

	Quantitative Sample (N = 129)			Qualitative Sample (N = 28)		
	%	*Mean*	*SD*	*%*	*Mean*	*SD*
Demographic variables						
Latino	100			100		
Other Races/Ethnicities	0			0		
Female	53			50		
Age		11.75	0.88		12.11	0.96
Grade Level: 6th	47			21		
Grade Level: 7th	33			43		
Grade Level: 8th	20			36		
Free/Reduced Lunch	96			100		
First-generation college student	99			100		
Family income less than $35,000	85			82		
School: A	36			46		
School: B	44			54		
School: C	20			0		
First year in the program	66			39		
Focal variables						
Perceived support for competence needs in the program		5.64	1.16		5.62	1.03
Perceived support for autonomy need in the program		5.38	1.04			
Perceived support for relatedness needs in the program		5.72	1.15			
Math ability self-concept: Post		5.05	1.13		5.19	0.89
Math ability self-concept: Pre		4.82	1.01		5.08	0.90
Math subjective task-value: Post		5.58	0.93		6.04	0.71
Math subjective task-value: Pre		5.90	1.10		5.76	1.00

Note. Sample size for quantitative sample (after multiple imputation) was 129; sample size for qualitative sample was 28. SD = standard deviation.

Prior to each weekly session, the program offered training through a university course where mentors were provided with opportunities to work as a reflective team to develop strategies for engaging adolescents, while at the same time, getting mentorship from professors and experts on math pedagogy and effective youth program practices. In addition to the weekly math curriculum, sample topics covered during the training sessions included engaging and connecting with students, promoting active learning, and facilitating culturally responsive practices, to name a few. Although most mentors voluntarily attended the training sessions, some took the course for university credits. The overall study was approved by an institutional review board for the protection of human subjects.

2.2. Positionality statement

Before presenting our methods, analyses, and results, our own relationship to the study data is important to explicate. We, the authors of this manuscript, are six individuals (5 women and 1 man) who identify as Asian and/or Pacific Islander (4), or White (2) of varying ages, who bring a relational, developmental, educational lens to understanding Latinx youth's experiences in afterschool programs. Together we have a wealth of developmental, cultural, academic, and professional experiences that informed our interpretation of the study findings and their implications for research and practice. For example, we all have interests in supporting diverse and under-represented students' STEM learning, have worked in educational settings and have published various academic works related to the topic. It is also important to note that the director of the math afterschool program on which this study is based is a co-author of this manuscript. Her perspective was critical in helping us contextualize the program and findings of the study. The remaining authors have no additional conflict-of-interests to disclose.

3. Quantitative method, analysis and results

3.1. Participants in the quantitative study

The quantitative analytic sample included 129 Latinx middle school students who were enrolled in the program for an academic year from fall 2018 to spring 2019 (~9 months). They accounted for 88% of all the program participants, as we only excluded 13 students who did not identify as Latinx and 4 students who participated in the program but did not complete the fall 2018 and spring 2019 pre- and post-surveys. Students in our quantitative analytic sample were on average 11.75 years old, 53% of them were female students, 96% qualified for free or reduced lunch, and 99% were from first-generation college student families with 85% of families earning less than $35,000 for an annual income (see Table 1).

3.2. Quantitative measure: Pre- and post-surveys

Students completed pre- and post-surveys during the academic year. The pre-survey took place in fall 2018 and measured students' demographic information and their math motivational beliefs. The post-survey was completed in spring 2019; it measured students' math motivational beliefs using the same items and students' perceived support for psychological needs in the program (i.e., competence, autonomy and relatedness needs). The surveys were available in English and Spanish though all students completed the English version.

3.2.1. Adolescents' math motivational beliefs

Students reported on two aspects of their math motivational beliefs: math ability self-concept and math subjective-task value (Eccles & Wigfield, 2020). Math ability self-concept measured students' self-perception of how good they thought they were in math based on four items ($\alpha = 0.81$; e.g., "How good at math are you," 1 = *Not good at all*, 7 = *Very good*). Subjective task-value measured the extent to which students valued math including their interest in math and how important math was to them. Students reported their math subjective-task value based on 5 items ($\alpha = 0.83$; e.g., "For me, being good in math is…" 1 = *Not at all important*, 7 = *Very important*). These measures have been used with English- and Spanish-speaking Latinx youth in prior research (e.g., Jacobs et al., 2002; Simpkins et al., 2015). In terms of psychometric properties, a measurement model with the two math motivational beliefs was estimated; the model demonstrated good fit[1] and all items loaded significantly onto their respective scales (p's < 0.001) (Hu & Bentler, 1999; Appendix A): $\chi2(21) = 27.06$, $p = .17$; CFI = 0.99, TFI = 0.98, RMSEA = 0.06, SRMR = 0.08.

3.2.2. Adolescents' perceived support for psychological needs in the program

Students reported their perceived support for competence, autonomy, and relatedness needs in the program based on the Basic Psychological Needs Satisfaction scales (Gagné, 2003). The perceived support for competence needs scale had 5 items ($\alpha = 0.79$; 1 = *Never*, 7 = *Always*; e.g., "I learn new and interesting skills in the [the program]"and "In [the program] I have a chance to show how capable I am"). The perceived support for autonomy needs scale also had 5 items ($\alpha = 0.59$; 1 = *Never*, 7 = *Always*; e.g., "I generally feel free to express my ideas and opinions in [the program]" and [reverse coded] "I frequently have to do what I

[1] Upon inspecting modification indices of the measurement model, the error terms of five pairs of items were correlated in order to achieve good fit.

Table 2
Bivariate correlations among key variables.

	1	2	3	4	5	6
1. Perceived support competence needs in the program	–					
2. Perceived support for autonomy needs in the program	0.57***	–				
3. Perceived support for relatedness needs in the program	0.77***	0.66***	–			
4. Math ability self-concept: Post	0.40***	0.14	0.17	–		
5. Math ability self-concept: Pre	0.26**	0.06	0.19*	0.72***	–	
6. Math subjective task-value: Post	0.43***	0.30***	0.38***	0.43***	0.32***	–
7. Math subjective task-value: Pre	0.35***	0.15	0.31***	0.51***	0.59***	0.51***

Note. Sample size (after multiple imputation) was 129.
* $p < .05$.
** $p < .01$.
*** $p < .001$.

Table 3
Students' math motivational beliefs predicted by perceived support for psychological needs.

	Post-survey math ability self-concept			Post-survey math subjective task value		
	(1)	(2)	(3)	(4)	(5)	(6)
Perceived support for competence needs in the program	0.25***			0.23*		
	(0.06)			(0.10)		
Perceived support for autonomy needs in the program		0.12			0.20	
		(0.07)			(0.11)	
Perceived support for relatedness needs in the program			0.07			0.20*
			(0.07)			(0.10)
Pre-survey math ability self-concept	0.58***	0.63***	0.62***			
	(0.06)	(0.06)	(0.06)			
Pre-survey math subjective task value				0.45***	0.50***	0.50***
				(0.09)	(0.09)	(0.09)
Female	−0.01	−0.04	−0.04	0.06	−0.01	0.00
	(0.12)	(0.13)	(0.13)	(0.16)	(0.16)	(0.16)
Seventh grade	−0.18	−0.15	−0.14	−0.20	−0.20	−0.23
	(0.18)	(0.20)	(0.20)	(0.24)	(0.24)	(0.24)
Eighth grade	0.29	0.29	0.33	−0.09	−0.14	−0.09
	(0.23)	(0.25)	(0.24)	(0.29)	(0.30)	(0.30)
School 1	0.36*	0.30	0.30	0.28	0.23	0.26
	(0.14)	(0.15)	(0.15)	(0.18)	(0.18)	(0.18)
School 3	−0.03	0.03	0.08	0.31	0.24	0.26
	(0.19)	(0.20)	(0.20)	(0.25)	(0.26)	(0.26)
First year in the program	−0.01	0.12	0.12	0.14	0.23	0.19
	(0.17)	(0.17)	(0.18)	(0.23)	(0.22)	(0.22)
Constant	0.71	1.22*	1.44*	1.53*	1.45*	1.58*
	(0.44)	(0.49)	(0.50)	(0.65)	(0.71)	(0.67)

Note. Models (1) and (4) had perceived support for competence needs as the main predictor, models (2) and (5) had perceived support for autonomy needs, while models (3) and (6) had perceived support for relatedness needs. Sixth grade school 2 are the omitted groups. Standard errors are in parentheses. Sample size (after multiple imputation) was 129.
** $p < .01$.
* $p < .05$.
*** $p < .001$.

am told to do in [the program]"). Lastly, the perceived support for relatedness scale had 6 items (α = 0.84; 1 = *Never*, 7 = *Always*; e.g., "People in [the program] care about me" and "I feel that there are many people I am close to in [the program]). High scores represent greater perceived support. The measures have been shown to have sound psychometrics with diverse populations (e.g., Johnston & Finney, 2010; Gagné, 2003). In terms of psychometric properties (see Appendix A), a measurement model of the three types of perceived support was estimated; the model demonstrated acceptable fit[2] and all items loaded significantly onto their respective scales ($p < .05$): $\chi 2(92) = 116.373$, $p = .04$; CFI = 0.96, TFI = 0.95, RMSEA = 0.06, SRMR = 0.07.

3.2.3. Covariates

We controlled for adolescents' pre-survey math motivational beliefs, gender (1 = *female*), grade level (with two dichotomous codes for the three grade levels), first-year status in the program, and school (with two dichotomous codes for the three schools) in our analysis.

3.3. Quantitative plan of analysis

We expected that adolescents' perception of support for competence, autonomy, and relatedness needs in the program would positively predict their post-survey math motivational beliefs, over and above their pre-survey math motivational beliefs and the set of covariates. Students' spring 2019 math motivational beliefs (i.e., ability self-concepts and subjective task-values) were regressed on one type of perceived support controlling for students' fall 2018 math motivational beliefs, gender, grade level, first-year status in the program, and school. Separate models were estimated for each type of perceived support. All data cleaning and analyses were done using STATA 14 (StataCorp, 2015). Before running any analysis, multiple imputation with 30 imputed datasets were conducted to address missing data. Missing ranged from $n = 5$ for fall 2018 math motivational belief scales to $n = 30$ for spring 2019 support and math motivational belief scales. The 30 participants (23% of

[2] Upon inspecting modification indices of the measurement model, the error terms of nine pairs of items were correlated in order to achieve acceptable fit.

participants) had fall 2018 data but missed the spring 2019 data collection. The following auxiliary variables were used to strengthen the imputation process: winter 2018 (mid-point between the pre- and post-survey) math ability self-concept and subjective task-value, income, and language that youth used to read and speak.

3.4. Quantitative results

Descriptive statistics and bivariate correlations among the key variables in this study are provided in Tables 1 and 2 respectively. As shown in Table 1, students on average felt their needs for competence (M = 5.64), autonomy (M = 5.38), and relatedness (M = 5.72) in the program were *sometimes* to *always* supported. Students' math ability self-concept increased from 4.82 (on the 1–7 scale) at pre-survey to 5.05 at post-survey ($t(128) = 2.88$, $p = .005$). On the other hand, students' math subjective task-value declined from 5.90 at pre-survey to 5.58 at post-survey ($t(128) = -2.27$, $p = .026$). The decrease in students' math subjective task-value beliefs aligns with prior research that demonstrates declines in students' motivational beliefs during adolescence (e.g., Jacobs, Lanza, Osgood, Eccles, & Wigfield, 2002; Nagy et al., 2010). We, however, found that students' math ability self-concept increased by the end of the program aligning with prior research on STEM after-school programs (e.g. Chittum et al., 2017). Future research is warranted to examine these differential associations including what key aspects of students' subjective task-values may need further attention and support in these settings.

As shown in Table 2, students' perceived support for competence, autonomy, and relatedness needs were significantly correlated with each other (r = 0.57–0.77, $p < .001$). Students' math ability self-concept and subjective task-value were significantly correlated with their perceived support for competence needs (r = 0.26–0.43, $p < .01$). With the exception of relatedness and ability self-concepts at the post-survey, students' ability self-concepts and task-values were correlated with their perceived relatedness support (r = 0.19–0.31, p < .05); they were not correlated with perceived autonomy support.

To test our hypothesis, we regressed students' post-survey measure of their math ability self-concept and values on their pre-survey math motivational belief indicators and other demographic factors (i.e., gender, grade level, school, first year in the program) and one indicator of perceived support. Separate regressions were estimated for each of the three indicators of perceived support given their strong bivariate correlations.

As presented in Table 3, students' perceived support for competence needs predicted both motivational beliefs. In contrast, student's perceived support for relatedness needs predicted one belief whereas their perceived support for autonomy needs did not predict any. Students' perceived support for competence needs in the program positively predicted their post-survey math ability self-concept ($\beta = 0.25$, $p < .001$) and subjective task-value ($\beta = 0.23$, $p < .05$), controlling for their pre-survey math motivational beliefs and other demographic factors. In other words, for students with similar motivational beliefs at the start of the program, those who perceived greater support for competence needs reported higher math ability self-concepts and subjective task-values at the end of the program than those who perceived less support for competence needs. In contrast, students' perceived support for autonomy needs in the program did not predict their post-survey math ability self-concept nor their subjective task-value (β = 0.12, 0.20, *ns*). This finding should be interpreted in light that our scale of perceived support for autonomy needs has a relatively low reliability, thus might be underpowered to demonstrate association with students' post-survey math motivational beliefs. Finally, students' perceived support for relatedness needs positively predicted their post-survey math subjective task-value ($\beta = 0.20$, $p < .05$), but not their math ability self-concept ($\beta = 0.07$, *ns*). As a robustness check, we re-estimated the associations between students' perceived support for competence, relatedness and autonomy needs and their post-survey math motivational beliefs among those with no missing data. As shown in Appendix B, the associations remained consistent even without multiple imputation for missing data.

In sum, we found that adolescents' perceived support for competence needs in the program, in particular, positively predicted both math ability self-concepts and subjective task-values. To further understand these relations and adolescents' experiences in the program, we turned to qualitative methods to examine adolescents' perceived competence support from their mentors in the program and its role in promoting adolescents' motivational beliefs in math.

4. Qualitative method, analysis, and results

4.1. Participants in the qualitative study

The qualitative analytic sample included 28 middle school students who were a part of the quantitative study. These students participated in in-depth interviews in the spring 2019. Students were purposely selected based on (a) how long they have been in the program (participated all year) and (b) their perceptions of program quality, followed by (c) a range of student demographics that reflected the larger program population. After identifying students who participated in the program all year, we stratified students based on their perceptions of program quality which included the measure of students' perceived competence support in the program. Fourteen out of the 28 participants (50%) represented students who rated the program as generally high-quality whereas seven (25%) rated the program as generally low-quality, and seven (25%) fell within the middle range in terms of their general rating of the program. This sampling strategy allowed us to have a range of students who differed in their perceptions of support in the program, helping us explore how competence-supportive practices can be represented and promoted in the program.[3] However, at the same time, we acknowledge that this sampling strategy resulted in having more students who rated the program as high-quality versus low-quality, which potentially limited our understanding of the range of experiences that students who perceive the program as low-quality may have in the program. Because we were interested in understanding Latinx student experiences, the sample of 28 students consisted of students who specifically identified as having Latinx heritage background. There was an equal number of students who identified as female (50%) and male (50%). Participants' ages ranged from 10 to 13 (M = 12.11). All 28 students qualified for free or reduced lunch and were from first-generation college student families, with 82% of families earning less than $35,000 for an annual income (see Table 1). Participants were paid $10 for an interview. The names in this study are pseudonyms which were selected by participants. In some instances, we replaced pseudonyms such as "Tree" to more discernible names (e.g., Tree to Teresa).

4.2. Qualitative measures: Interview protocol

During in-depth semi-structured interviews, adolescents reflected on their experiences and interactions with their mentors in the program. Interviews lasted an average of 60 min (ranging from 45 to 75 min). Adolescents were given the option to be interviewed in English and/or in Spanish. Twenty-seven of the 28 students preferred to be interviewed in English. The one student who preferred Spanish was interviewed by a Latina bilingual researcher using a pre-translated Spanish version of the interview protocol. The protocol consisted of five sections: (1) general questions about the adolescents, (2) general program experiences, (3)

[3] In the current study, although we examined differences between students who rated the program as generally low-, moderate- or high-quality, we did not find meaningful differences in students' perceptions of support for competence needs. The themes that we identified were relevant to all the students despite their general view of the program's quality.

Table 4
Qualitative Findings: Adolescents' competence-related skills and support from mentors.

Adolescents' competence-related skills		Support from mentors	
Category	Examples	Theme description	Sub-themes and key examples
Adolescents leveraging their funds of knowledge for problem-solving during math activities	*"Here you can express how you normally do math. The way you learned it in school and then build from it."* *"I learned to use real-life examples. When using real-life examples, you don't have to do the way others teach you, you can use real life examples that might help you understand [the math problems] more clearly."* *"Here I can remember and show [my mentors] the way my parents taught me math and the way they learned it in Mexico."*	**Mentors supporting adolescents to leverage their knowledge related to (1) their learning experiences, (2) real-life examples, and 3) their cultural backgrounds** (n = 28 or 100%)	**Validating and helping to create connections across adolescents' learning experiences** (n = 26 or 93%) *"We talk about how we do it at school and [my mentor] tells me related things about what I said. She makes me better explain where I am coming from."* **Providing real-life examples during math activities** (n = 15 or 54%) *"When [my mentor] uses real-life examples, I feel it's easier to understand and solve the math problems because with real-life examples, some people do it and it actually works."* **Validating and welcoming adolescents' cultural backgrounds** (n = 28) *"[Our mentor], he won't care if we speak Spanish to one another because he knows that for some of us, that's our first language and some words, we don't know how to say [in English]."* (n = 27 or 96%)
Adolescents leveraging various strategies and perspectives for problem-solving during math activities	*'I get to learn new math, math in different ways based on different cultures, and different strategies…that's what I've learned. I see many kids doing math differently. I get amazed by different ways of math and the strategies you can use."*	**Mentors supporting adolescents to leverage various strategies and perspectives** (n = 28 or 100%)	**Helping adolescents learn new and more engaging and effective strategies for problem-solving** (n = 25 or 89%) *"I learned new ways of solving problems. They have cool tricks that they've explained to me on how to do certain things."* **Validating adolescents' unique perspectives** (n = 20 or 71%) *"He's really nice. He lets you talk so that your opinion matters. Not like opinion, but like, maybe I have a different idea or how to solve the problem… he lets you talk."* **Helping adolescents focus on the learning process rather than the correct answer to math problems** (n = 23 or 82%) *"When we're trying different ways to solve something and we do it all wrong…we have to do it again and then we get it at the end because he explains it, what we did wrong and why."* **Utilizing diverse teaching strategies** (n = 25 or 89%) *"For some questions they add different parts. So then you have to answer each so you could understand what they really mean."* *"They would always explain things on whiteboards or use different things like blocks or sticks or cards to represent the problems. They would always try to draw it out or give you a visual representation of what you're doing."*

perceptions of adolescent-staff relationships, (4) perceptions of cultural responsiveness, and a section on (5) outcomes and skills. For the purpose of the study, the latter four sections of the protocol were primarily utilized for analysis. Example interview questions include: "What do you like about [the program?]", "Tell me something you think you have learned from your mentor(s)", "In what ways, if at all, does [the program] support your culture?" and "Has being in [the program] changed the way you think or feel about math? In what ways? What things has it changed?". For the full study interview protocol see Soto-Lara, Yu, Pantano, and Simpkins (2021).

Interviewers were instructed to ask follow-up questions in order to encourage adolescents to elaborate on their responses and provide specific examples. The first author and three graduate students conducted the interviews. Prior to the interviews, graduate students participated in interviewing workshops and feedback sessions led by the first author, an experienced qualitative researcher. The majority of the interviewers were women (75%) and identified as Latinx (75%) or as Asian and Pacific Islander (25%). Interviews were audio-recorded, transcribed verbatim using GoTranscript (an online transcription service), and then checked by research assistants for accuracy. The interview conducted in Spanish was transcribed, translated to English, and checked by two Latina bilingual research assistants.

4.3. Qualitative analysis

Below we discuss our analytical process which involved two stages: (1) an initial coding of skills that adolescents reported in the program, followed by (2) a thematic analysis of adolescents' perceived support for competence-related skills. We also discuss our reflexivity and efforts to audit our analytical process and findings.

4.3.1. Stage 1. Initial coding of competence-related skills that adolescents reported in the program

As part of the larger study, the research team developed initial a priori codes encompassing the goals of the study including identifying the competence-related skills that adolescents reported developing in the program. Drawing on prior literature (e.g., Eccles & Wigfield, 2020; Ryan & Deci, 2020), we defined competence-related skills broadly as skills related to adolescents' development and practice of mastery and problem-solving in the program. Each interview transcript was coded using Dedoose Version 8.3.17, a cloud-based qualitative data analysis application (Dedoose, 2020). The research team met weekly to address coding questions and to ensure inter-rater reliability through a consensus process guided by consensual qualitative research methods (Hill et al., 2005). Specifically, two coders were assigned to every transcript; after both coders independently coded a transcript for competence-related skills, they compared codes and reconciled any discrepancies. Discrepancies which the coders could not reconcile were brought to a larger group meeting and reconciled by the entire coding team led by the first author, who also served as an auditor of the coding process (Hill et al., 2005).

4.3.2. Stage 2. Thematic analysis of adolescents' perceived support for competence-related skills

The second stage of the analysis involved conducting a thematic analysis (Braun & Clarke, 2012) on the specific excerpts representing examples of competence-related skills that adolescents reported developing in the program (stage 1), with the specific purpose of identifying the ways in which the program, and mentors in particular, supported the learning process related to adolescents' development and practice of mastery and problem-solving skills. This analytical stage focused on identifying themes related to adolescents' perceptions of how the program and their mentors provided a competence-supportive environment and helped to promote their motivational beliefs in math. First, the three researchers conducted an inductive analysis of the excerpts by individually identifying initial codes that appeared interesting and meaningful, while also memoing to begin developing overarching themes within the data. Second, the researchers met to discuss initial codes and memos across all excerpts. Based on initial codes (e.g., connecting students' learning experiences, validating students' knowledge and backgrounds, scaffolding), researchers conducted a more targeted analysis of transcripts which involved identifying patterns across the initial codes and all of the transcripts. During this iterative process, we drew from prior literature, frameworks and theory on program quality and cultural responsiveness (e.g., Eccles & Gootman, 2002; Simpkins et al., 2017), which served as "sensitizing concepts" (Charmaz, 2014), and attuned us to emergent codes in the data while also helping us contextualize the significance of the subsequent categories and themes. As an example, several of the themes we identified shed light on ways that mentors helped leverage youth's "funds of knowledge", which Simpkins et al. (2017) posit as being an important aspect of culturally responsive practices. Once themes were created, the transcripts were coded and reconciled by two research assistants similarly to the consensus process described above.

4.3.3. Auditing of our analytical process and findings

To balance our perspectives and audit our analytical process and findings, we presented our codebook and preliminary analyses during group meetings that included researchers that were familiar with the larger study but were not directly involved with the data analysis. Importantly, these group meetings included Latinx researchers who provided feedback and further context for some of our findings related to Latinx cultural processes (e.g., speaking in Spanish) and values (e.g., familial and educational values). Additionally, we sought informant feedback by consulting with other interviewers, mentors, and coordinators from the larger study and program to corroborate the themes and key examples. Their feedback helped to shape the way in which we presented the data to ensure that it was representative of their understanding of Latinx adolescents' experiences in the program.

4.4. Qualitative results

We identified two categories of competence-related skills that adolescents reported in the program: (1) leveraging their funds of knowledge and (2) leveraging various strategies and perspectives for problem-solving during math activities. In the following sections, we describe the ways that mentors supported adolescents' development and practice of these skills and their role in promoting adolescents' motivational beliefs in math. In doing so, we extend and build on the quantitative findings of the current study by illuminating specific examples of perceived competence-supportive practices in the program and their relation to changes in adolescents' math motivational beliefs. Themes and subthemes within each category are italicized below. Table 4 provides a summary including the number and percentage of adolescents that reported each theme. In general, the two major themes were reported by 100% of the adolescents ($n = 28$). The percentage of adolescents who reported the subthemes ranged from 54% ($n = 15$) to 93% ($n = 26$).

4.4.1. Mentors supporting adolescents to leverage their funds of knowledge

The first theme involves *mentors supporting adolescents to leverage their funds of knowledge*. Mentors played a key role in the learning process by *validating and helping to create connections across adolescents' learning experiences* (Subtheme 1), *providing real-life examples during math activities* (Subtheme 2), and *validating and welcoming adolescents' cultural backgrounds* (Subtheme 3).

First, with respect to their learning experiences, adolescents described the program as being a welcoming space to express and build on their school math knowledge and learning experiences:

> I get to do it how I know… from how my teachers used to teach me. – Karen
> Here you can express how you normally do math. The way you learned it in school and then build from it. – Fernando

In these examples, the adolescents referenced being able to use and build off of their school experiences in the context of the math activities in the program (e.g., tasks, games). Mentors played an important role in supporting the learning process for adolescents by *validating* their opinions, "what [they] know," and "the way [they] do math." To support this process further, mentors *created connections across adolescents' learning experiences* in school and the program to empower their perspectives:

> We talk about how we do it at school and [my mentor] tells me related things about what I said. She makes me better explain where I am coming from. – Fernando

In this example, Fernando was describing his mentor helping him "think through" a math activity topic that he was not very familiar with by drawing attention to what he already understood about the topic. By helping to create connections across adolescents' learning experiences from school to the program, mentors provided adolescents with opportunities to build on their competence skills during math activities. These opportunities helped to promote adolescents' perceptions of their math ability self-concept by validating their funds of knowledge related to their school experiences. Importantly, this learning process was reciprocal, in the sense that adolescents also gained new knowledge in the program that they applied later at school, which promoted their perceived math ability self-concept more generally. This was reflected in Belen's description of the connections between her experiences in school and in the program:

> Oh, I remember learning about that in [the program]. I'll use my knowledge from there into my classes. I could do things faster and then get even more difficult math problems.

Like Belen, other adolescents described bridging their learning from the program to their school experiences, and vice versa, which helped increase their perceived math ability self-concept and their confidence "to do math" in any context. This idea was exemplified by Karen who said:

> "I learned how to do math in [the program] and learn how to do it in [school]… it makes me know that I can do it anywhere else."

Mentors also helped adolescents leverage their knowledge in the context of real-life examples for problem-solving during math activities. The significance of utilizing real-life examples was exemplified in the following interview excerpts from Izzy:

> I learned to use real-life examples. When using real-life examples, you don't have to do the way others teach you, you can use real-life examples that might help you understand [the math problems] more clearly.

Although the real-life examples utilized by mentors varied, it often involved interpreting and analyzing math problems in the context of real-life scenarios including, for example, managing money effectively when shopping, understanding math tessellation patterns using nature, and interpreting ratios in the context of ingredients for cooking recipes. When asked about the role of their mentors in supporting them, Izzy described his mentor facilitating connections by *providing real-life examples* during math activities:

> When [my mentor] uses real-life examples, I feel it's easier to understand and solve the math problems because with real-life examples, some people do it and it actually works!

By using real-life examples, mentors made math problems easier to understand which in turn helped promote adolescents' positive sense of their math ability self-concept:

> It makes me feel smarter because sometimes I don't get the problems but then she uses real-life examples and I pretty much get it. I feel more capable of doing the math. – Izzy

In addition to leveraging adolescents' funds of knowledge based on their school experiences and real-life examples, mentors supported students' math ability self-concept by *validating and welcoming their cultural backgrounds* during math activities, e.g., by using familiar contexts in math problems examples (soccer, native fruits and Spanish names, to list a few) and by using educational approaches similar to the ones used by the adolescents' families (such as collaborative learning and games like La Lotería). These efforts validated adolescents' funds of knowledge related to their cultural backgrounds and helped adolescents feel better supported by the program and their mentors:

> [The program supports my culture] because my family works together as a group and everything we do here is working as a group so it reminds me of my family. – Ramon
> Here I can remember and show [my mentors] the way my parents taught me math and the way they learned it in Mexico. – Karen

Although the ways that mentors supported adolescents' funds of knowledge related to their cultural backgrounds varied across adolescents, a consistent aspect of adolescents' perceived competence-supportive experiences in the program was the importance of being able to engage in opportunities for collaborative learning. For many of the adolescents in the program, this provided a sense of predictability and comfort because it was a learning strategy that reflected their Latinx familial values related to the importance of working together. Additionally, adolescents also noted how their cultural knowledge and language were welcomed and reflected in program practices. These practices included the use of Spanish to think through math problems with fellow Spanish-speaking mentors and students. Non-Spanish-speaking mentors helped support this process by providing a welcoming space for adolescents:

> Since we're Latino, we speak Spanish to each other. [Our mentor], he won't care if we speak Spanish to one another because he knows that for some of us, that's our first language and some words, we don't know how to say [in English]. – Olivero

Adolescents described conversing in Spanish as a way to better understand math problems, which in turn helped facilitate their problem-solving skills during the math activities. Importantly, being able to leverage their funds of knowledge related to their cultural background also helped promote their math subjective task-values:

> It's helped me not overthink in math. It makes me feel like, "Okay, this is very important to me and my family. I'm going to need this to help them. I need to really think about it." It gives me more confidence to actually work on it. – Leticia

For Leticia specifically, being able to leverage her funds of knowledge related to her cultural background helped her gain confidence in her math ability as well as see the importance of math for her future and to help her family. Similarly, other students noted gaining skills to better support and teach others "how to do math" and why "math is important."

Overall, adolescents described leveraging their funds of knowledge related to their learning experiences, in the context of real-life examples and their cultural backgrounds as ways to showcase their skills during math activities in the program. Mentors played a key role in the learning process by validating and helping create connections across adolescents' learning experiences in school and the program, providing real-life examples during problem-solving attempts, and validating and welcoming adolescents' cultural backgrounds. These supports facilitated adolescents' math motivational beliefs by helping them feel more capable of doing math and seeing the importance of math in their lives and future. Considering the quantitative findings which highlighted that perceived support for relatedness needs was predictive of adolescents' math subjective-task values but not their math ability self-concepts, these qualitative findings showcase the important interrelation between competence and relatedness supports in providing a culturally responsive space that is conducive for the promotion of adolescents' motivational beliefs in math. Not only mentors intentionally leveraged adolescents' funds of knowledge to connect and relate with adolescents, but they also leveraged these assets to make learning more relevant to adolescents' cultural backgrounds and experiences. In the process, they helped promote both adolescents' math ability self-concepts and subjective-values. These findings additionally suggest that relatedness support alone may not be enough to promote adolescents' math motivational beliefs but that when combined with competence support, it can make meaningful difference.

4.4.2. Mentors supporting adolescents to leverage various strategies and perspectives

The second theme involves *mentors supporting adolescents to leverage various strategies and perspectives*. This theme stemmed from adolescents' description of the program context as a diverse and inclusive space to learn and express different ways of problem-solving during math activities:

> I get to learn new math, math in different ways based on different cultures, and different strategies…that's what I've learned. I see many kids doing math differently. I get amazed by different ways of math and the strategies you can use. – Via

Mentors helped support the learning process including *helping adolescents learn new and more engaging and effective strategies for problem-solving* (Subtheme 1); *validating adolescents' unique perspectives* (Subtheme 2); *helping adolescents focus on the learning process rather than the correct answer to math problems* (Subtheme 3); and utilizing *diverse teaching strategies* (Subtheme 4).

First, adolescents described their *mentors helping them develop new and more engaging and effective ways of problem-solving*:

> I learned new ways of solving problems. They have cool tricks that they've explained to me on how to do certain things. – Adam
> When you have to figure out other ways to do stuff. If there's one really easy way and one really hard way to do it, the mentor shows us, "this is a shorter and easier way." – Olivero

Some adolescents juxtaposed their experiences in the program with the experiences that they had at school where they noted learning about math "only in one way" or at times, in "boring ways." Importantly, in addition to learning new and more engaging and effective strategies for problem-solving from their mentors, adolescents described the importance of their *mentors considering their unique perspectives*:

> When we are doing math, he'll have a bunch of ways to do it, but then, some of the things I do, he's never even tried before, so we try my way of solving the problem. – Adam
> He's really nice. He lets you talk so that your opinion matters. Not like opinion, but like, maybe I have a different idea or how to solve the problem…he lets you talk. – Vanessa

For adolescents, the fact that their mentors validated and provided a platform for their perspectives and contributions represented that their mentors cared for and respected them. This process seemed to undergird the benefits that adolescents derived from working with their mentors, in that they were not only able to learn various problem-solving strategies from their mentors, but they were also able to express and build upon their own unique perspectives in the process.

To further help adolescents leverage various strategies and perspectives, mentors made efforts to work together with adolescents and emphasize collective efforts over individual mistakes:

> They would work with me and help me even when they know I could fail most of the time. They say, "it's okay, try to do this" and try to teach me in a simpler way. – Juanita
> When we're trying different ways to solve something and we do it all wrong…we have to do it again and then we get it at the end because he explains it, what we did wrong and why. – Jennifer

These examples showcase how, through collaborative learning processes, mentors empowered adolescents to co-construct and contribute to the processes of teaching and learning in the program. Importantly, mentors also worked with adolescents and *normalized the learning process over getting the correct answer to problems*. Doing so helped promote adolescents' confidence in their math ability and problem-solving skills more generally:

> They push us to do this, to figure it out in different ways so that we get it for the next time and understand it and believe that we're good at math. – Olivero
> I tend to do [math] problems wrong when I don't think and do it too quickly. Now I think, I calm down, and I do it…not only math but maybe when I have other problems like in school or with my friends and they have their own opinions. – Luigi
> They helped me to learn how to deal with math and all sorts of problems outside of math in different ways and so that we are prepared for anything that comes our way. –Lily

By leveraging various strategies and perspectives, adolescents described anticipating and persisting through problems during math activities which helped promote their confidence in their math ability. At the same time, they described a similar learning process for dealing with challenging situations within their personal lives (e.g., problems in school, conflict with friends) in part because of their experience in the program and the support they received from their mentors. Similar to the first theme of mentors leveraging adolescents' funds of knowledge, these examples highlight the deep nature of adolescents' learning experiences in the program which transcended to their personal lives outside of the program.

Mentors also utilized *diverse teaching strategies* including investing time to break down math problems into more manageable parts (scaffolding), providing adolescents with personalized support, and utilizing different resources and manipulatives:

> For some questions they add different parts. So then you have to answer each so you could understand what they really mean. – Vanessa
> They're really helpful. If we don't understand something, they'll take time to explain it until we do it or find another way to explain it for us to understand it our way. – Teresa
> They would always explain things on whiteboards or use different things like blocks or sticks or cards to represent the problems. They would always try to draw it out or give you a visual representation of what you're doing. That really helped to understand the [math problems] more clearly. – Leticia

Through diverse teaching strategies, mentors helped adolescents believe that math was not only "doable," but also interesting and fun, thereby promoting their math subjective task-value:

> Learning different ways of doing math refreshes our mind and makes us *think higher of math* instead of just this boring subject that no one likes. (emphasis added) – Belen
> Math is my worst subject in school, but the program *helped me a lot.* [My mentors] showed me that math was actually fun, and like, even if it seemed hard, you could still do it and you could find a way to do it good. (emphasis added) – Jasmine

Although several adolescents reported a significant increase in their math subjective task-values, it is important to note that this was not the case for all of the adolescents in the program. For example, in response to whether being in the program changed the way they thought or felt about math, some said:

> Um, no. I've learned more math. That's it. - Rowland
> Not really because I've always liked math, so it hasn't really changed anything. There are some topics here that for me were a bit boring because I've already learned them. - Teresa
> I'm liking math just a little bit more. [But] I still prefer language arts. - Amy
> Yeah, it has. Now that I'm learning new math, I'm starting to come back to math again. Originally it was my favorite subject, but I didn't like it anymore, but now I'm starting to respect it again. - Santiago

As this range of examples suggests, there were adolescents who reported "no change" in their math subjective task-values and other students who reported only minor changes based on their preference for other subjects and their program experiences. Moreover, there were some students who described learning math in the program but not necessarily increasing their interest in the subject. There were also students like Santiago who described a more fluid development of his interest in math over time. Perhaps not surprisingly, these students tended to be ones that rated the program as low quality. These examples illuminate an important finding in the quantitative analysis that highlighted how, on average, adolescents' subjective-task value decreased over time in the program which aligned with the typical trend in early adolescence (e.g., Chittum et al., 2017; Jacobs et al., 2002), speaking to the importance of adolescents' perceptions of support in the program. Although participation in the program did not increase every student's math subjective-task values, it can be argued that for some students, it helped maintain and at times even revert (for the better) their interest in math over time.

Overall, adolescents described leveraging various strategies and perspectives in the program which helped facilitate their math motivational beliefs by promoting their confidence in their math abilities and broader interests in math. Mentors played a key role in the learning process by not only helping adolescents develop various strategies, but also scaffolding new and more engaging and effective ways of problem-solving during math activities. Mentors considered adolescents' unique perspectives and emphasized the learning process over the correct answer to math problems. In light of the quantitative findings, these qualitative findings showcase how competence support may interrelate with autonomy support which together can serve to acknowledge and validate adolescents' efforts and persistence, as well as create opportunities for them to work and learn in their own way (Niemiec & Ryan, 2009). Mentors made efforts to implement diverse teaching strategies including scaffolding, providing adolescents with personalized supports, and utilizing different resources and manipulatives to ensure adolescents' understanding. Building on the quantitative findings of the current study, these findings help illuminate the ways in which perceived support for competence needs can help meet adolescents' diverse learning needs and provide them with skill building opportunities in developmentally appropriate ways.

5. Discussion

Utilizing mixed methods, this study examined the important role that STEM afterschool programs can play in promoting Latinx adolescents' motivational beliefs through perceived support for competence, autonomy, and relatedness needs. Utilizing quantitative methods, we found that adolescents on average reported increases in their math ability self-concepts but declines in their math subjective task-values. Additionally, adolescents who perceived greater support for competence needs in the program reported higher post-survey math motivational beliefs compared to adolescents who perceived less support for competence needs, controlling for pre-survey math motivational beliefs and a set of demographic covariates. We followed up on these findings by utilizing qualitative methods to further understand adolescents' perceptions of competence support from their mentors in the program. Findings highlight the two central themes that align with culturally responsive practices (Simpkins et al., 2017): connecting to adolescents' funds of knowledge related to their learning experiences and in the context of real-life examples and their cultural backgrounds; and engaging adolescents in activities that help them learn and utilize various strategies and perspectives for problem-solving.

5.1. Changes in math motivational beliefs during early adolescence

Early adolescence is an important period for students' motivational beliefs in STEM (Tai et al., 2006). Unfortunately, youth's motivational beliefs in math and STEM more broadly are likely to diminish during this period (e.g., Chittum et al., 2017; Jacobs et al., 2002; Osborne et al., 2003). Our study findings highlight how math afterschool programs might help mitigate these declines. Specifically, with respect to math ability self-concept, we found that adolescents' motivational beliefs, on average, increased over time. On the other hand, the finding related to changes in adolescents' math subjective task-value was much more complex in that although we found that these beliefs on average declined over time, findings from the qualitative component of our study highlighted ways in which the program actually helped to increase, maintain or revert (for the better) students' interest in math over time. These findings point to the rich and nuanced heterogeneity of adolescents' math motivational beliefs. While it is useful to see the average change, qualitative insights further enriched our understanding by shedding light on experiences that could counter the average trend.

5.2. Adolescents' perceived support for competence needs and math motivational beliefs

Aligned with Situated Expectancy Value Theory and Self-Determination Theory (Eccles & Wigfield, 2020; Ryan & Deci, 2020), we found that adolescents' perceived support for competence needs in the program helped promote their math ability self-concepts and their math subjective task-values. Through our qualitative analysis, we found that adolescents' perceived support from their mentors were core elements of whether they felt the program environment supported their competencies. These supports helped facilitate adolescents' math motivational beliefs in key ways including promoting their confidence in their math abilities (i.e., math ability self-concept). With respect to math subjective task-value, *mentors supporting adolescents to leverage their funds of knowledge* helped them see the importance of math in their lives and future while *mentors supporting adolescents to leverage various strategies and perspectives* helped adolescents see how math can be "engaging" and "fun" thereby helping to promote their broader interests in math. Extending prior research, our findings highlight the specific ways mentors' support of adolescents' need for competence can help promote key aspects of their math motivational beliefs.

5.3. Implications for culturally responsive practices

Findings from this study point to the importance of culturally responsive to support adolescents' need for competence and their motivational beliefs in math. Advancing the current literature, we identified specific ways in which mentors were culturally responsive. For example, mentors validated adolescents' funds of knowledge and intentionally created connections across adolescents' learning contexts. They considered adolescents' real-world experiences as assets to the learning process. They welcomed adolescents' unique cultural values, knowledge and engaged in meaningful learning activities with adolescents (e.g., collaborative learning, games). In line with previous research on Latinx youth experiences within afterschool school programs (e.g., Yu et al., 2020, Yu et al., 2021; McGovern, Raffaelli, Moreno Garcia, & Larson, 2020) these practices represent how acknowledging and leveraging Latinx youth's funds of knowledge can more effectively support their learning and engagement. As shown in this current study, these supports made the learning process easier for adolescents to navigate and strengthened their connections with their mentors. Importantly, these supports also helped adolescents feel more confident about their math abilities and consider the importance of math in their lives.

Our findings further highlight the significance of implementing developmentally appropriate strategies as part of culturally responsive practices. During early adolescence, youth begin to engage in progressively complex and instigative activities and thus may need more support to navigate the learning process from adults (Yu, Johnson, Deutsch, & Varga, 2018; Yu & Deutsch, 2021). The mentors in our study supported this developmental process in key ways by implementing a range of engaging and diverse teaching strategies including scaffolding, providing personalized support, and utilizing different resources and manipulatives to support adolescents' learning experiences in the program. In line with research on program best practices for promoting competence-supportive environments (e.g., Smith et al., 2016; Vance, 2018), the mentors in our study also took a youth-centered approach by playing a more facilitative rather than a directive role in the learning process. They normalized the learning process over getting the correct answer to math problems and provided adolescents with intentional opportunities to showcase their perspectives and strengths. Doing so helped adolescents adapt their understanding of the math activities in the program, co-construct their learning experiences, and persist through their problem-solving attempts. As a result, they gained confidence in their math abilities and also described wanting to engage with the math activities and being invested in it. Together these findings advance research by highlighting characteristics of positive mentorship (e.g., support for students' funds of knowledge), the underlying mechanisms of support in these relationships (e.g., diverse teaching strategies), and features of afterschool settings (e.g., collaborative learning) that can foster high-quality mentoring relationships.

Overall, extending prior research, our study provides evidence for the importance of aligning mentoring practices to early adolescents' developmental needs (Yu & Deutsch, 2021) as well as practices that are not only engaging but culturally responsive to adolescents' varied contexts and learning experiences (National Research Council, 2015; Simpkins et al., 2017). As shown in our study, these practices may have strong implications for supporting young adolescents' motivational beliefs in math. These practices may be especially important for Latinx youth who often face critical challenges and structural barriers in their pursuit of STEM (Fry & Gonzales, 2008; NSF, 2019) and who may benefit from their participation in afterschool STEM afterschool programs (Krishnamurthi et al., 2014; NRC, 2015; Simpkins et al., 2017). By focusing on Latinx youth's STEM motivation experiences, our study makes a significant contribution by providing needed attention and theory-guided work on diverse, understudied populations in motivation research (Schunk & DiBenedetto, 2020; Wigfield & Koenka, 2020).

5.4. Contributions to motivation research and theory

Our study makes additional contributions to the literature on motivation research and theory. For example, by utilizing quantitative and qualitative methods to study practices that help support positive changes in Latinx adolescents' motivational beliefs, our study addresses recent calls in the field of educational psychology to embed more mixed methods and a more situative approach to the study of motivation (e.g., Eccles & Wigfield, 2020; Nolen, 2020; Ryan & Deci, 2020). Previous research on motivation and motivation theories have largely focused on the "impact of variables on variables" (Nolen, 2020; p. 3) and much less on the particular situations and multiple layers of contexts in which youth grow and develop (Eccles & Wigfield, 2020). By delving into the specific role of socializers (mentors) and related social and cultural processes that lead to the development of Latinx adolescents' motivational beliefs, our study makes a valuable contribution to the literature on what competence support looks like in context and in practice and the different ways it can promote students' motivational beliefs. Importantly, we explain what this relationship can look like according to youth's developmental needs and cultural backgrounds, leading to new insights about the processes behind motivational theories including SEVT and SDT. In the case of SEVT, for example, we addressed a gap in the theory related to understanding what type of support may help promote adolescents' confidence in their math abilities and value of math. With respect to SDT, we concretized how adult socializers (mentors) can provide support for adolescents' need for competence. By drawing on both SEVT and SDT as guiding constructs, the findings provide a deeper understanding of perceived support for competence needs and changes in students' math motivational beliefs as Latinx youth and young adolescents. By integrating SEVT and SDT, we add to current discussions in motivation research and theory about the importance of "precision and utility" (Anderman, 2020) by providing a more nuanced view of the factors that promote Latinx adolescents' math motivational beliefs in order to generate more specific and meaningful implications for educational practice.

5.5. Strengths, limitations, and future directions

One strength of this study was our use of mixed methods, which not only allowed us to examine the relationship between perceived support for competence needs and adolescents' motivational beliefs in math within a specific program, but also *how* and *why* competence-supportive mentoring practices were related to adolescents' experiences and outcomes in the program. Although the extent to which our findings can be generalized is limited, we expect our findings to be relevant to a diverse array of programs. STEM programs for underserved youth, including afterschool programs for underserved Latinx youth similar to the program in our study (e.g., Sheperd & Sakashita, 2009), are on the rise but more research is needed to understand their impact (Krishnamurthi et al., 2014).

A second strength of our study is that we focused on Latinx adolescents' perspectives in the program, which are critical in designing and implementing culturally responsive programs that are ultimately effective for them. However, this design also comes with limitations as it represents a specific perspective. Triangulation of multiple perspectives including staff and objective third-party observers can uncover a fuller picture of the processes of competence-supportive practices in programs and why and how practices are ultimately related to adolescents' experiences and outcomes in these settings.

A third strength, with respect to our study design, is that we leveraged data that were collected 9 months apart. We demonstrated how perceived support for competence needs was positively associated with math motivational beliefs even while holding constant prior math motivational beliefs and a set of demographic covariates. This is an important contribution to literature as many studies are not often able to collect data for more than one time point, which makes comparisons concerning because people have different starting points. Building on our findings, more longitudinal data could further infer how the associations between competence support and adolescent math motivational beliefs persist or potentially fadeout over time.

Lastly, our study contributed to the literature by examining in-detail, specific practices that can help to meet adolescents' need for competence, which according to SDT is an essential foundation for adolescents' motivational beliefs. Future studies could further explore how the other two needs under the theory, namely autonomy and relatedness, could also be separately and/or concurrently supported in programs. These needs are complex and thus future studies should continue to identify best practices that can help programs to effectively support them.

6. Conclusion

Students' math ability self-concepts and math subjective task-values are susceptible to declines in early adolescence. Our study filled an important gap in literature focused on the need to understand how perceived support for competence needs in afterschool programs can help promote these specific motivational beliefs for young Latinx adolescents. Our study highlights specific culturally responsive practices - including helping adolescents leverage their funds of knowledge as well as various strategies and perspectives for problem-solving during math activities - that afterschool programs and mentors can utilize to create supportive learning environments for competence needs that help to promote adolescents' math motivational beliefs.

Declaration of Competing Interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

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Appendix

See Appendix Tables A and B

Appendix A
Model fit indices for measurement models.

	Measurement model of math motivational beliefs[1]	Measurement model of perceived support for psychological needs[1]
Likelihood ratio chi-square	$\chi^2(21) = 27.06$, p = .17	$\chi^2(92) = 116.373$, $p = .04$
Comparative fit index (CFI)	0.99	0.96
Tucker-Lewis index (TFI)	0.98	0.95
Root mean square error of approximation (RMSEA)	0.06	0.06
Standardized root mean square residual (SRMR)	0.08	0.07

Note. Suggested model fit thresholds based on Hu and Bentler (1999) are: $p > .05$ for likelihood ratio chi-square, CFI > 0.95, TFI > 0.95, RMSEA < 0.06, and SRMR < 0.08. [1] Upon inspecting modification indices of the measurement models, the error terms of five and nine pairs of items were correlated in order to achieve good fit for the math motivational belief and perceived support for psychological needs models respectively.

Appendix B
Students' math motivational beliefs predicted by perceived support for psychological needs, among students with complete data (i.e., no imputation for missing data).

	Post-survey math ability self-concept			Post-survey math subjective task value		
	(1)	(2)	(3)	(4)	(5)	(6)
Perceived support for competence needs in the program	0.24***			0.21*		
	(0.07)			(0.09)		
Perceived support for autonomy needs in the program		0.10			0.14	
		(0.08)			(0.09)	
Perceived support for relatedness needs in the program			0.06			0.19*
			(0.07)			(0.09)
Pre-survey math ability self-concept	0.61***	0.68***	0.68***			
	(0.06)	(0.06)	(0.06)			
Pre-survey math subjective task value				0.49***	0.56***	0.51***
				(0.09)	(0.08)	(0.09)
Female	0.00	−0.04	−0.04	0.03	−0.04	−0.03
	(0.12)	(0.13)	(0.13)	(0.15)	(0.15)	(0.15)
Seventh grade	−0.20	−0.18	−0.18	−0.45	−0.42	−0.48*
	(0.19)	(0.20)	(0.21)	(0.23)	(0.24)	(0.24)
Eighth grade	0.24	0.21	0.22	−0.12	−0.14	−0.17
	(0.23)	(0.24)	(0.24)	(0.28)	(0.29)	(0.28)
School 1	0.43**	0.37*	0.37*	0.30	0.26	0.28
	(0.14)	(0.15)	(0.15)	(0.18)	(0.18)	(0.18)
School 3	0.04	0.06	0.09	0.13	0.13	0.08
	(0.20)	(0.22)	(0.22)	(0.25)	(0.26)	(0.25)
First year in the program	−0.01	0.13	0.14	0.16	0.26	0.21
	(0.17)	(0.18)	(0.18)	(0.21)	(0.21)	(0.21)
Constant	0.56	1.02	1.24*	1.59*	1.62*	1.57*
	(0.44)	(0.51)	(0.49)	(0.58)	(0.64)	(0.60)

Note. Models (1) and (4) had perceived support for competence needs as the main predictor, models (2) and (5) had perceived support for autonomy needs, while models (3) and (6) had perceived support for relatedness needs. Sixth grade school 2 are the omitted groups. Standard errors are in parentheses. Sample size (without multiple imputation) was 94.

* $p < .05$.
** $p < .01$.
*** $p < .001$.

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