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Breaking Barriers: Evaluating a Pilot STEM Intervention for Latinx Children of Spanish-Speaking Families

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Abstract
STEM achievement gaps between Latinx and their non-Hispanic White (NHW) counterparts emerge in early childhood and persist through adulthood. Culturally relevant STEM interventions can help counter some of the Latinx higher attrition rates in STEM, especially if they are initiated in elementary school. This study assesses the feasibility, acceptability, and impact on STEM Career Interest of an evidence-based, after-school STEM Program for elementary school Latinx children from Spanish-speaking families. Twenty-three 3rd to 5th grade children in a dual-language school in Colorado participated in 8 weekly STEM lessons, a field trip, and a culturally relevant fair with Latinx STEM professional role models. The following measures were used: (1) attendance rates, (2) changes in a STEM Career Interest Survey, and (3) children and caregivers' reported satisfaction with the program. Attendance and satisfaction with the program were high. Students' STEM Career Interest showed a statistically significant increase between pre- and post-program; however, the subscales of the *STEM Career Interest Survey* did not show a significant increase. It was feasible to implement the STEM interest program at the center of this study with elementary school Latinx students, and the program demonstrated success in increasing students' STEM Career Interest. Moreover, the program is novel in that it addresses a significant barrier to economic mobility in the Spanish-speaking Latinx community (i.e., the high attrition rates in STEM participation). With some adaptations (e.g., longer duration), this program can serve as a model for interventions in other schools or academic settings.

Keywords Latinx · After-school STEM · STEM intervention · English-language learners · STEM motivation

Feasibility of a STEM Intervention for Latinx Children from Spanish-Speaking Families

Latinx, i.e., individuals of Latin American origin or descent, are the largest minority group in the US public school system (27.7%; United States Census Bureau, 2017; U.S. Department of Education, 2016). In Colorado, over 30% of the K-12 population is Latinx (Colorado Department of Education, 2018). In Denver, Latinx represent 57.5% of the students in the Denver School District (Denver Children's Affairs, 2014). Therefore, Latinx constitute a large share of K-12 students in US, Colorado, and Denver schools, and the percentage of this population is projected to grow dramatically in upcoming years (National Council of La Raza, 2016).

The representation of Latinx gradually declines throughout K-12 education, college, and the workforce (National Science Foundation, 2019). While Latinx account for 17% of the US population, only 9% of STEM degrees and certificates go to Latinx (vs. 65.6% for non-Hispanic Whites [NHWs], or individuals who are White but do not report Hispanic origin; National Center for Education Statistics, 2015; National Science Board, 2014). Among those whose highest degree is in STEM, Latinx have a higher rate of unemployment than NHWs (National Science Board, 2014). Less than 2% of the STEM workforce is Latinx (National Center for Education Statistics, 2015). Latinx with credentials in STEM professions are more likely to be in lower-paying occupations (e.g., chemical technicians) than higher-paying ones (e.g., electrical engineers) (Funk & Parker, 2018). While the median income for Latinx is $59,000, the income of Latinx in STEM careers is $77,000 (United States Census Bureau,

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2013). Closing the STEM career gap can help close the earnings gap between Latinx and NHWs (Lynch et al., 2018).

Achievement gaps between Latinx and their NHW counterparts emerge in early childhood and persist through adulthood (Murphey et al., 2017). Currently, Colorado has the second largest degree attainment gap in the country (Colorado Department of Higher Education, 2019). Latinx enter Kindergarten with average math skills 3 months behind those of NHWs (Lindsey & Howard, 2013; Murphey et al., 2017; Reardon & Galindo, 2007, 2009). Latinx score lower than NHWs on math and science achievement tests in Denver Public Schools (Campbell, 2018) and at the national level (Musu-Gillette et al., 2017; Hemphill et al., 2011; Villareal et al., 2012), and drop out of math and science classes as early as elementary school (Villareal et al., 2012). These statistics are alarming, considering that early mathematics learning is associated with the development of skills and dispositions that support multiple areas of learning and cognitive ability (Murphey et al., 2017).

Latinx children whose families speak primarily Spanish at home (English-language learners; ELL) tend to have math scores that lag behind the scores of their Latinx counterparts (Murphey et al., 2017). Starting in Kindergarten, Latinx with the least English exposure are considerably less proficient than Latinx students from homes where English is spoken (Reardon & Galindo, 2007). ELL families tend to have math scores that are approximately 5 weeks of learning behind their Latinx counterparts from English-speaking families (Murphey et al., 2017).

Among STEM employees, less encouragement from an early age is listed as a top reason why few Latinx are working in the field (Funk & Parker, 2018; Gamboa, 2018; Villareal et al., 2012). Exposing Latinx students to culturally relevant STEM-focused education and Latinx role models in STEM at early ages can increase their interest in STEM fields and eventual participation in the STEM workforce, leading to increased academic performance and long-term broader economic opportunities (Lynch et al., 2018). Despite the need for these culturally relevant STEM-focused interventions, few have been developed for ELLs.

Culturally relevant STEM interventions can help counter some of the high attrition rates of Latinx in STEM, especially if they are initiated in elementary school (Avendano et al., 2018; Calabrese Barton & Tan, 2018; Lynch et al., 2018; Menshew et al., 2018). STEM interventions should be geared toward creating an initial interest in STEM, i.e., concentrate on the affective sphere (Banerjee, 2016; Jones, 2018; Kupersmidt et al., 2018; Lynch et al., 2018; Menshew et al., 2018). An understanding of and interest in science emerge from the opportunity to observe a phenomenon, come up with testable observations, and report findings (Calabrese Barton & Tan, 2018; Etkina, 2015; Etkina & Van Heuvelen, 2007; Jones, 2018; Lynch et al., 2018). Other best practices include culturally responsive teaching that views cultural differences as strengths and assets to learning (Menshew et al., 2018; Lynch et al., 2018; Ruff, 2017); using place-based learning that is experiential and allows for students to make connections between STEM and daily living (Jones, 2018; Lynch et al., 2018), providing contact with successful STEM professionals with shared identities, which can help underrepresented students envision themselves in STEM fields (Avendano et al., 2018), and encouraging involvement of caregivers (Banerjee, 2016).

In a constantly changing STEM industry, soft or "third space" skills (i.e., critical thinking, learning to learn, taking initiative, working collaboratively with others) are necessary for success (Lynch et al., 2018; Pradhan, 2016). Fostering third space skills requires (1) incorporating hands-on experiences and (2) going beyond rote learning and integrating emotions, e.g. respect for students' individuality and culture, and cognition (Lynch et al., 2018; Pradhan, 2016). In addition, for minority students such as Latinx, fostering third space skills is best achieved in a collective third space, that is interactionally constructed, equity-minded, and where the dominant forms of knowledge and learning are replaced by ways of knowing and learning that are characteristic of and familiar to Latinx (Gutiérrez, 2008). This social environment of development resists the binaries of formal and informal learning spaces, and, in it, students are able to reconceptualize themselves in relation to others and achieve academically (Gutiérrez, 2008).

Teachers who seek to bridge STEM lessons with Spanish and Latinx children face a number of challenges including limited access to relevant resources, students' feelings of stereotype threat, and connected caregiver involvement (Avendano et al., 2018; Canales-Vela, 2017; Quintana et al., 2012). Relevant resources in Spanish are not as widely available as in English creating a challenge for teachers who attempt to deliver STEM lessons in Spanish (Canales-Vela, 2017). For an after-school STEM program for Latinx elementary students to be successful, teachers should have help developing an authentic, dual-language curriculum and be allowed time to talk and reflect with other bilingual STEM educators (Avendano et al., 2018; Canales-Vela, 2017). Teachers with experience working with ELLs and who have an understanding of the cultural and systemic influences at play may have the most success in developing and implementing such a curriculum (Avendano et al., 2018; Calabrese Barton & Tan, 2018; Lynch et al., 2018).

Latinx students often face negative stereotypes about their academic ability (Gonzalez et al., 2002) and their probability of succeeding in a STEM field (Gandara & Contreras, 2009; Hernandez et al., 2017). Calabrese Barton and Tan (2018) claim: "How people are welcomed, positioned, and recognized for what they know and can do in a making space shapes the culture of learning and participation that happens there." Exposure to role models in STEM can significantly impact students' academic and career path by improving their self-concept, sense of belonging, self-efficacy, and attitudes toward domains in which they are unrepresented (Hernandez et al., 2017; Stiles, 2016). Conversely, a lack of role models can decrease students' motivation to pursue a STEM career. Menshew et al. (2018) found Hispanic role models in STEM were an important deciding factor in whether Hispanic high school students pursued STEM opportunities earlier on in their education. Stiles (2016) and Lynch et al. (2018) provided the following recommendations to increase representation for STEM program participants: (1) representing the target population within the research and teaching team and (2) partnering with community STEM organizations (e.g., museums), so students can build connections between real-world job opportunities and STEM learning.

The literature on underrepresentation in STEM highlights the importance of caregiver involvement. Parental support can directly impact underserved student involvement in STEM; increased support has been shown to increase motivation and retention of these STEM learners (Ruff, 2017). In the Latinx community, it is necessary for teachers to encourage parent participation in a culturally informed manner (Calabrese Barton & Tan, 2018). Latinx parents hold education to a high value but often find it disrespectful to become too involved and may deem it a sign of disrespect or distrust to the teacher and their abilities (Hernandez et al., 2016). STEM teachers working with Latinx students need to understand these cultural factors and encourage parental involvement accordingly (Hernandez et al., 2016). This may mean incorporating parent involvement strategically throughout the implementation of the after-school program and providing incentives for family participation.

Summer may be a crucial time for children to continue to learn STEM (Hernandez et al., 2016). Latinx students' perceptions of STEM success also supports that summer learning may be an important way to keep students interested and engaged and to reduce the variability in growth seen between students from different SES backgrounds (Hill, 2017; Thanawala, 2016).

Conceptual Framework

This study employs the evaluation framework proposed in the NRC Committee that reviewed K12 Mathematics Curricular Evaluations (National Research Council, 2004). This framework defines curricular effectiveness as "the extent to which a curricular program and its implementation produce a positive and curricularly valid outcomes for students…" Following the framework, we (1) describe a STEM pilot program curriculum, (2) detail the program as implemented, in its cultural context, and (3) present evidence of learner engagement (i.e., feasibility and acceptability) and program impact on student STEM Career Interest (i.e., effectiveness). We named the program *PODER: Latinx in STEM*.

The NRC Guidelines suggest the following major components in program design and evaluation: program components, implementation components, and student outcomes. We have articulated the program theory using NRC guidelines as program components (i.e., curricular design), implementation components (i.e., resources, processes, and contextual influences), secondary components (e.g., barriers to implementation), and student outcomes (i.e., attendance and attitudes). The curriculum in *PODER* was designed to foster third space skills in a culturally relevant way for ELL Latinx students, using an inquiry-based framework, and with attention to different learning styles. The program was delivered after school by school teachers who were involved in program development and evaluation and adequately compensated. Program outcomes included attendance (feasibility), student satisfaction (acceptability), caregiver satisfaction (acceptability), and changes in STEM career interest (effectiveness as it pertains to this iteration of the program). See Fig. 1.

Purpose of this Study

This study sought to answer the following core research questions: (1) Is *PODER: Latinx in STEM*, an innovative after-school STEM pilot program for elementary school ELL Latinx, feasible to implement and accepted by elementary school ELL Latinx and their families? (2) What is the impact of *PODER* on elementary school ELL Latinx students' STEM career interest? The purpose of *PODER* is to build upon existing evidence-based practices and community efforts to increase interest in and access to math and science knowledge among Latinx students, in particular those coming from Spanish-speaking families, thereby impacting their potential to participate in STEM and partake in careers that have higher-than-average earnings (i.e., STEM professions). After-school interventions for ELL Latinx that meet the characteristics described above (i.e., a culturally investigative environment geared toward the affective sphere, led by trained Latinx teachers, involving culturally relevant role models and parents, and spanning through summer) are scarce in the educational literature.

Method

Participants

Twenty-three 3rd to 5th grade elementary school ELL Latinx children participated in the program. All students attended

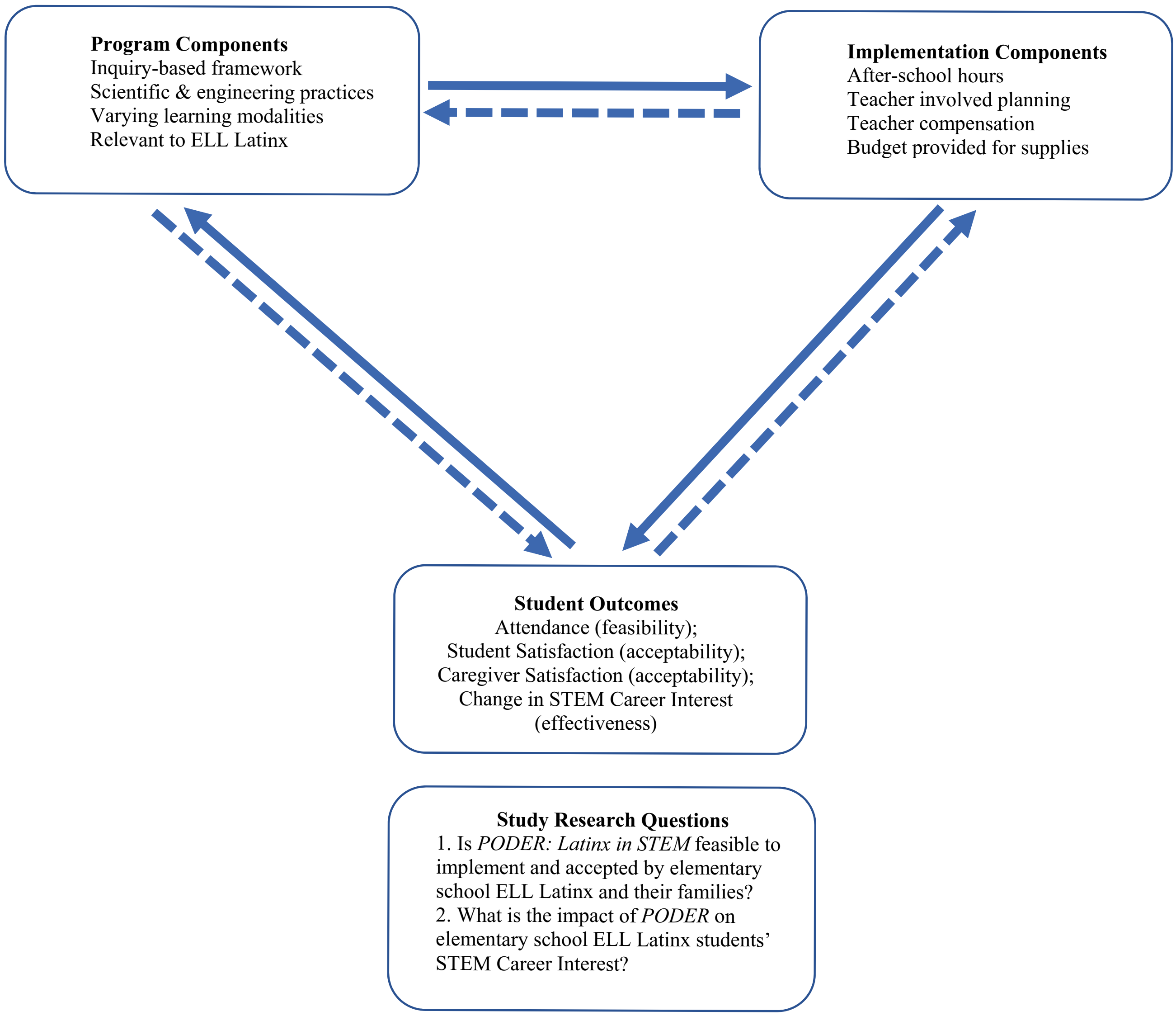

Fig. 1 Program framework (based on National Research Council, 2004)

a dual-language school in Colorado and had a self-reported preference for learning in Spanish (vs. English). Of the participants, 11 (47.8%) self-identified as female, and 12 (52.2%) self-identified as male.

While the school overall meets or exceeds most measures of student performance, ELL Latinx perform at a lower level than NHWs, particularly in math. In the Colorado Measures of Academic Success (CMAS; the state's common measurement of students' progress at the end of the school year), English-language learners at the school perform consistently worse in math than non-ELLs. The participants' school enrolls about 400 students starting in early childhood education, up to 5th grade. Of the students at the school, 64% are Latinx and 51% qualify for free or reduced-rate lunch. The percentage of children who met or exceeded expectations in math in the last few years was 20% ELLs vs. 86% non-ELLs (2017), 29% ELLs vs. 83% non-ELLs (2018), and 22% ELLs vs. 75% non-ELLs (2019). Although this gap is narrowing, the leadership at the school remains eager to try new interventions to improve learning outcomes of Latinx students in math. The proposed program was at the request of the school leadership and fits with these efforts. The program was led by two teachers. The first teacher self-identifies as Latina and is a Montessori Spanish teacher in ECE 3-4 at the school where the program was implemented. The second teacher self-identifies as White and is Spanish-English bilingual; she is a math interventionist at the school.

Procedure

This study was approved by the Institutional Review Board (IRB) where the first author of this study is based and also by the IRB in the school district, which mainly represented prospective participants. The methodology was devised in collaboration with community partners. The research team (two Latinx Ph.D.-level principal investigators, an MA-level student, and a doctoral student) along with staff at the school (school principal, family liaison, and two teachers) were involved in program planning and implementation and evaluation. Engaging relevant stakeholders at all stages of *PODER* helped us meet House's principles of (1) truth, or a focus on what is considered evidence by community itself; (2) beauty, or attention to information that would be credible and coherent to community given the context of the program; and (3) "justice as fairness" (social justice), by introducing a program that focused on re-distribution of power and resources in a culturally responsive manner (Bledsoe, 2014; House & Howe, 2000; Segerholm, 2010).

Enrollment Students from eligible (Spanish-speaking) families received a flyer, in Spanish, from the teachers, inviting them to participate. The flyer explained the purpose and logistics (days/times) of the program, stated the names of the two teachers who would run the program, and asked families to express initial interest by filling out their name and preferred day of the week (the program was run twice a week, with children divided into two groups that learned the same content). Students returned this initial expression of interest to the teachers and were divided into two groups, based on preferred day of the week and availability, and were notified of their group assignment. Families with interest in participating were asked to attend the school on their first day of the program. On this day, children assented and caregivers consented to participation, in either Spanish or English, with support from bilingual/bicultural researchers.

Data Collection Students completed the STEM Career Interest Survey (Kier et al., 2014) on the first and last day of classes. Students and their caregivers completed the Student Satisfaction Questionnaire (Winsch, 2013) and Caregiver Satisfaction Questionnaire (Atlanta Speech School, n.d.; Rogers et al., 2009) on the last day of program. Teachers recorded attendance to the different program components each session of the program.

Intervention Components *PODER* consists of three main components: (1) 8 weekly after-school lessons, (2) a field trip, and (3) a culminating event or fair open to children and their families. All components were led by bilingual, certified teachers from the school where the intervention was implemented.

Eight weekly after-school sessions (per group) were conducted. Prior to each session, students were given a snack. Great emphasis was placed on community building among students. For example, students received a T-shirt with the program logo and were allowed to wear it in lieu of the school uniform.

Program sessions were in Spanish and had an inquiry-based framework for instruction and engaged students in specific scientific and engineering practices using a variety of learning modalities (e.g., kinesthetic, visual, etc.). All content was designed by the teachers leading the program and adapted to be culturally relevant to ELL Latinx. The content covered in each weekly 60-min session was (1) light and color vision, (2) liquid density, (3) friction (rolling cars and car racing), (4) and (5) circuit boards and circuits in daily life (e.g., washing machine and light interruptor), (6) water pressure, (7) storing kinetic energy (elastic and springs), and (8) desalinization. Students were exposed to a phenomenon and invited to come up with testable observations, allowing students to connect the basic scientific principles they were witnessing with how they experience these principles in every day contexts. For example, to learn about light and color vision, students built an Artificial Spectrum Top (a.k.a., Benham Top), tried it, and came up with their own theories of what they were witnessing, and then had a class discussion. Although students claimed at baseline that they did not have people in their lives who studied science, they had the opportunity to see themselves as scientists, to resolve day-to-day "enigmas."

Teachers met weekly, along with the two PIs, to discuss progress with this program component. Teachers were compensated for preparing the lessons and teaching the program at a rate of $100/class hour and also received $800 to purchase curriculum, materials, and course supplies (shared among the two teachers).

Students also participated in a field trip to a local archeological site and an archeology museum. The field-trip presentation was conducted both in English (by the on-site tour guides) and Spanish (translated by the teacher). This hands-on program component gave children an opportunity to interact with the bones and tracks of dinosaurs as well as unique geologic features. Students learned about fossils/rock layers and how they form, and how ancient climates are different from today and have changed over time. Students had time for observations and questions, engaging in the scientific method at a developmentally appropriate level. Children's families were invited to join this field trip.

A culminating event was held at the end of the 8-week program where students met Latinx working in STEM careers to serve as role models similar to a career fair. The professionals at the different booths interacted with students and their families to provide hands-on experiences that illustrated "a day in the life" of their jobs. The goals of this event were to expose guests to role models in STEM careers, break stereotypes about STEM careers, and provide students with opportunities for STEM-based explorations in order to build their academic confidence and interest in STEM careers. Students had opportunities to share their experiences in the program and to earn a certificate for participating. The event was held on a Friday evening for 4 h and was open to children and their families. During the event, Latin music was played, and food was provided for students, families, and role models.

Students participating in the program received a $7 Amazon gift card for each after-school session they attended (for a maximum of $56 per student) and a program T-shirt. Finally, to maintain student interest in STEM and curb any loss of interest or knowledge that may occur after the end of the school year, students also received a monthly STEM activity box to their homes over summer (3 total). The activity boxes, ordered on Amazon, contained different projects and experiments aimed to help kids learn about science, while also fostering creativity and ingenuity. One of the boxes was a "mind-blowing science kit," a 20-piece kit that allowed students to explore and learn the basics of science from chemical reactions to the use of science tools. The second box included a reactor and instructions to perform real-world science experiments. The third box was a light-up terrarium kit for kids to create a mini garden in a jar that glows at night.

Measures

The following measures were used: attendance rates, the STEM Career Interest Survey (STEM-CIS; Kier et al., 2014), and satisfaction reports for both students (Winsch, 2013) and caregivers. Attendance rates were collected each session (including the field trip and final fair) by program teachers. The STEM Career Interest Survey (Kier et al., 2014) was administered to students in the first and final sessions of the program (i.e., pre- and post-intervention). The program satisfaction surveys were administered to students and their caregivers at the end of the program (i.e., post-intervention).

STEM Career Interest Survey The STEM Career Interest Survey (Kier et al., 2014) was developed as a 44-item survey to assess middle school student interest in both classes and careers in science, technology, engineering, and mathematics with 11 comparable items for each of the four STEM categories. The scale was developed following Lent et al. (1994) social cognitive career theory (SCCT) to predict interest and intent to pursue academic choices and careers. The SCCT model proposes the following variables as explanatory of students' interest and career choice: self-efficacy, outcome expectations, personal inputs and background, and contextual support or barriers (Kier et al., 2014). Thus, the STEM-CIS measures not only interest in STEM but also what factors influence interest by including the following subscales: self-efficacy, personal goals, outcome expectations, interest in science, contextual support, and personal input (Kier et al., 2014). Using confirmatory factor analysis, the subscales were tested individually as well as together and showed the instrument sub-scales were reliable for use as either stand-alone or as a unit (Kier et al., 2014). The Cronbach's alpha for the Science sub-scale used in this study was $\alpha = .77$. Using a 5-point Likert scale, where *1* = strongly disagree and *5* = strongly agree, students are asked questions such as "I am able to get a good grade in my science class," "If I do well in my science class, it will help me in my future career," and "I have a role model in my science career" (Kier et al., 2014). Scores can range from 11 to 55.

Student Program Satisfaction Survey This measure was originally developed by the Kentucky Science Center to analyze student satisfaction of a pilot after-school science program being implemented in several elementary schools, all of which have free and reduced lunch rates above 50% (Winsch, 2013). In general, satisfaction surveys for after-school programs have not been published or tested with any of the rigor of academic assessments; hence, this study utilized surveys (for both the student and caregiver survey) that were publicly available, STEM focused, and appropriate for the age of students. Students were asked to respond to the survey assessing their overall satisfaction with the program. Four items were based on a 4-point Likert scale asking questions such as "How interesting were the sessions overall" where *1* = not interesting at all and *4* = extremely interesting. Students were asked how many opportunities they had to actively participate in sessions and ask questions, where responses ranged from *1* = no opportunities and *4* = constant opportunities. The students were then asked if they would recommend this program, where *1*= definitely no and *4* = definitely yes. Finally, two open-ended questions allowed the children to "tell us two of your favorite things about this program" and "how we can improve the program for next time." Total scores can range from 4 to 16.

Caregiver Satisfaction Survey Caregivers were also asked to assess their satisfaction with the program. This measure combined two existing caregiver/parent satisfaction surveys, one developed by Rogers et al. (2009) and the other by the Atlanta Speech School (n.d.). Both of the surveys were originally used to assess satisfaction with after-school programs but were not tested in these programs for reliability or validity. Two questions were drawn from the Parent Survey on Afterschool Programs (Rogers et al., 2009), where, using a 4-point Likert scale, participants were asked how they would rate the overall quality of the program with *1* = poor and *4* =

Table 1 Measure descriptive statistics

	Number	Mean	*SD*	Min	Max
STEM Survey—Pre	23	42.65	5.84	32	55
STEM Survey—Post	19	44.21	5.52	30	52
Caregiver satisfaction	22	36.50	1.14	32	37
Student satisfaction	22	13.32	1.46	11	16

excellent. They were also asked how much their child liked the program using a 3-point Likert scale (*1* = not at all, *3* = a lot). The remaining six questions, drawn from the After-School Parent Satisfaction Survey (Atlanta Speech School, n. d.), used a 5-point Likert scale (*1* = I'm not sure, *5* = strongly agree) and asked questions like "My child had fun in the program," "I would like it if my child chose a science career," and "I would recommend this program to others." Survey scores can range from 8 to 37.

Results

Student and parent surveys were analyzed using SPSS (v. 26) to determine the frequency of responses. Since the sample size was small, comments from the students were independently compiled into thematic groups by two of the researchers and then combined for final results. To respect their time constraints (i.e., limited availability), caregivers only provided quantitative feedback. Teacher comments were provided directly to the research team.

Learner Engagement

Attendance Overall, there were 23 children who participated in this pilot program, 12 in the Monday class, and 11 in the Wednesday class. Attendance rates were high and speak to the feasibility of the program, with 69.57% of the children making it to all the sessions. Four students missed once (17.39%), 2 students missed two sessions (9%), and one student missed 4 sessions (4%). All participants went

Table 2 Correlation between survey instruments

	STEM survey—pre	STEM survey—post	Caregiver satisfaction	Student satisfaction
STEM Survey—Pre	1	.665**	.512*	.553**
STEM Survey—Post		1	.661**	.167
Caregiver satisfaction			1	.100
Student satisfaction				1

*Correlation statistically significant at .05 level (two-tailed); **Correlation statistically significant at the .01 level (two-tailed)

Table 3 Survey sub-score descriptive statistics

Category	Number	Mean	SD	Min	Max
Self-efficacy					
Pre	23	8.00	1.35	6	10
Post	21	7.81	1.44	4	10
Personal goals					
Pre	23	8.65	1.40	6	10
Post	20	8.60	1.43	6	10
Outcome expectations					
Pre	23	7.96	1.33	6	10
Post	20	8.45	1.36	6	10
Interest in science					
Pre	23	7.96	1.46	6	10
Post	22	8.82	1.40	5	10
Contextual support and barriers					
Pre	23	6.09	2.11	2	10
Post	22	6.45	2.76	2	10
Personal inputs					
Pre	23	4.00	.95	2	5
Post	22	3.95	.84	2	5

on the field trip, and 6 students missed the career fair (3 of whom had also missed two or more sessions). Six families joined the field trip.

Satisfaction Out of the 23 participants, return rates for the surveys for this sample were good, with 19 (82.7%) program career interest surveys returned and 22 (95.7%) for both the caregiver and student satisfaction surveys. Scores across each of the surveys were summed to derive a survey total. Descriptive statistics for the summed totals for the pre- and post-program and child and caregiver satisfaction surveys can be seen in Table 1. Additionally, survey instrument correlations can be seen in Table 2. Both the students and caregivers reported high satisfaction with the program (M = 13.32, SD = 1.46; and M = 36.50, SD = 1.14, respectively), which spoke to the acceptability of the program.

Students were asked to list their favorite things about the program. Of the 19 satisfaction surveys returned, all 19 children provided comments with some children citing multiple items. While limited by the total number of responses, four primary themes emerged. The *first theme* was centered on enthusiasm for the various components of the program's activities (10 comments). Children enjoyed the program's experiments themselves (e.g., "When we did the catapult and the circuits" and "I like when we did the monster lights and when we did the balloon project"). The *second theme* centered on the children enjoying the field trip and end-of-program celebration (6 comments), though no detailed comments regarding these two program components were provided. The *third theme* was about the

Table 4 Evaluation table for PODER: Latinx in STEM

Research questions	Data sources/measures	When data was collected	Results
Feasibility. Is *PODER: Latinx in STEM*, an innovative after-school STEM pilot program for elementary school ELL Latinx, feasible to implement?	Attendance	Every session, by teachers	70% students attended all sessions 17% students missed 1 session 9% students missed 2 sessions 4% students missed 4 sessions
Acceptability. Is *PODER: Latinx in STEM*, an innovative after-school STEM pilot program for elementary school ELL Latinx, accepted by elementary school ELL Latinx and their families?	Satisfaction Report for Students (Winsch, 2013)	Post-intervention	Quantitative M= 13.32 (possible range: 4-16) Min= 11, Max = 16, *SD*= 1.46 Qualitative Strengths: • Enjoyment of program experiments • Enjoyment of field trip and end of program celebration • Intertwining of fun and learning • Community and social aspects of the program Areas of growth: • Adding more science and topic expansion • Increase collaboration with peers and role models • Program logistics (dates, times, length of session)
	Satisfaction Report by Caregivers	Post-intervention	Quantitative M = 36.5 (possible range: 8–37) Min= 32, Max= 37, *SD*= 1.14 Qualitative Did not assess
Acceptability (cont'd) Is *PODER: Latinx in STEM*, an innovative after-school STEM pilot program for elementary school ELL Latinx, accepted by elementary school ELL Latinx and their families?	Teacher Satisfaction, qualitative	Post-intervention	Qualitative Strengths: • Promoted excitement and learning in ELL students • Students asked for the program to be repeated • "Total success" (quote by both teachers) Areas of growth: • Should have one point of contact/administrator Have families pay small fee to attend rather than providing incentives to the children • Additional assistant in the classroom during the program

Table 4 (continued)

Effectiveness.			
What is the impact of *PODER* on elementary school ELL Latinx students' STEM Career Interest?	*STEM Career Interest Survey* (Kier et al., 2014)	Baseline Post-intervention	An independent-samples *t* test between the pre- and post-sum STEM Career Interest score was not statistically significant, $t(18) = -1.035$, $p = .31$. Subscale mean score changes, as measured by t-tests: • Interest showed a statistically significant increase, ($t(21) = -2.306$, $p < .05$). This sub-scale included the two questions "I am interested in careers that use science" and "I like my science class." • Self-efficacy, no significant change, $p = .22$; • Personal goals, no significant change, $p = .68$; • Outcome expectations, no significant change, $p = .24$; • Contextual support, no significant change, $p = .67$; • Personal inputs, no significant change, $p = .73$

intertwining of fun and learning (5 comments). For example, students said, "One thing is that I could do fun things and that you learned a lot of things," and "The activities were fun learning opportunities. The activities were more interesting and fun than in class." The *fourth theme* (2 comments) was regarding the community and social aspects of this program, particularly the opportunity to participate along friends and classmates (e.g., "One of my favorites is doing experiments and being together").

Students were also asked to share how the program could be improved in its next iteration. There were three primary categories of feedback. The *first theme* centered around program improvement (7 comments) and included ideas such as adding "more science," and expanding the topics (e.g., "They can teach about other things"). The *second theme* was increased collaboration with peers and role models (5 comments), which included comments like "invite professionals working in the industry," and "invite a person from your class and work together." The *third theme* focused on program logistics (4 comments), specifically requesting different dates, times, and even adding more time to each session as there was not ample time to complete the project. Qualitative feedback from the teachers was centered around the following strengths: the program promoted excitement and learning in ELL students, and students asked for the program to be repeated. Qualitative feedback from the teachers also highlighted the following areas of growth: there should have been one point of contact/administrator; families should have to pay to attend vs. being providing incentives to children; there should be additional assistant in the classroom as activities are really hands-on. To respect their time and limited availability, the parents were not asked to provide qualitative feedback.

Impact on STEM Career Interest Student pre- ($M = 42.65$, $SD = 5.84$) and post- ($M = 44.21$, $SD = 5.52$) program total scores in the STEM Career Interest Survey (Kier et al., 2014) were relatively high with a maximum possible score of 55. Students' STEM Career Interest at baseline was correlated to overall student program satisfaction ($r = .553$, $p < .01$). Not surprisingly, pre- and post-program STEM Career Interest scores were also found to be correlated ($r = .665$, $p < .01$). Post-program student STEM Career Interest scores were related to caregiver program satisfaction ($r = .661$, $p < .01$) but not student program satisfaction ($p = .50$). An independent-samples *t* test between the pre- and post-sum score was not statistically significant, $t(18) = -1.035$, $p = .31$. There was no correlational relationship between parent satisfaction and student satisfaction ($p = .66$). All results were limited by the small sample set.

Subscores were calculated for each STEM-CIS subscale: Self-Efficacy, Personal Goals, Outcome Expectations, Interest in Science, Personal Inputs, and Contextual Support and Barriers; subscores were tallied (see Tables 3 and 4 for descriptive statistics). Of these, Interest showed a statistically significant increase between pre- and post-program mean scores, ($t(21) = -2.306$, $p < .05$). This sub-scale included the two questions "I am interested in careers that use science" and "I like my science class." Self-efficacy ($p = .22$), Personal Goals ($p = .68$), Outcome Expectations ($p = .24$), Contextual Support ($p = .67$), and Personal Inputs ($p = .73$) did not show significant mean differences.

Discussion

PODER: Latinx in STEM was designed as an innovative after-school STEM program for elementary school ELL Latinx children. The program is evidence-based, anchored in existing best-practices for STEM interventions and builds on existing community efforts to reduce the math achievement gap in Colorado elementary school students. Thinking of education as a historical, context-based process of change, in this section, we discuss results, with attention to context, pre-conditions, and how the program was carried out (Segerholm, 2010).

This pilot study suggests that it is feasible to implement *PODER* with elementary school ELL Latinx students. Students attended the majority of sessions and were, per the teachers' report, very engaged. Additionally, both students and caregivers readily accepted the intervention as demonstrated by their high satisfaction scores. In addition, this program is novel in that it situates the STEM experience within the existing (ELL Latinx) cultural context of students, with respect for culture and recognition of their interests. *PODER* represents a third space with the potential for expanded ways of learning and knowing. Creating this third space allows for the "identification of both possibility and constraint within and across contexts" (Gutiérrez, 2008).

Even though our sample is small, our results show some evidence that this program fostered third space skills that line up with current STEM industry needs (Lynch et al., 2018; Pradhan, 2016). Student responses are in line with existing literature showing that key program components (themes) were an investigative environment that highlights the affective ("fun"), place-based learning ("field trip and end-of-program celebration"), a strong sense of community ("community and social aspects") (Banerjee, 2016; Jones, 2018; Kupersmidt et al., 2018). Suggestions for program improvement provided by students and families also line up with existing literature, highlighting collaboration with STEM role models on projects and peers (Avendano et al., 2018; Hernandez et al., 2017; Stiles, 2016). These results support the value of early (K-5) creation of learning environments where students build STEM social capital, as proposed by Lynch et al. (2018).

This program was successful in significantly increasing students' interest in STEM. As feedback for future iterations of the program, all families requested the program be repeated, including more time for programming and more science activities. The program did not have a significant impact on students' self-efficacy, personal goals, outcome expectations, contextual support, or personal inputs. Given the short duration of the program (8 weeks), this was in some ways predictable and could possibly also be explained by the barriers that were encountered during program implementation. First, after the families registered for the program, there was a teacher strike at the school district level that halted the start of the program for a month. Once the program was launched, during its implementation, there were 3 consecutive snow days on Wednesdays. As the end of the academic year was approaching, one of the groups had four sessions in the period of 2 weeks, toward the end of Week 8, to make up for missed sessions due to inclement weather. It is possible that the provision of mastery experiences, as was done in this program, may have increased students' interest in STEM; however, other personal modifiable variables, e.g., self-efficacy and outcome expectations, may take longer to change. Additionally, a more systematic implementation of the program may also allow for increased family involvement.

Implications

The STEM opportunities offered to students in *PODER* can be seen both as educational opportunities in themselves and also as avenues to other opportunities that map on well to the needs of the STEM industry. Among the opportunities provided by *PODER*, we count access to teachers who are supportive, peers with similar goals and interests, and role models with experience in the field. *PODER* gave students information, experiences, and behavioral scaffolding that fostered the soft skills needed to succeed in STEM (Lynch et al., 2018).

Limitations

This intervention showed both promising results and some limitations. Given that the intervention was a pilot, it had a small sample size and a short follow-up period. Running the intervention with a larger sample over a more extended period of time could possibly have an effect on students' STEM Career Interest. The lack of a control group is another limitation. The researchers faced a tradeoff between having a small sample size of Latinx students exposed to the intervention or having that population split into treatment and control groups of even smaller sizes. Nearly all the ELL Latinx students in the age ranges in the target school participated but provided only 22 observations. As a pilot project, it was more important to expose more students to the intervention and see what changes could happen within the group than to have some of the students not exposed to the experiences, while still not having a large enough sample size to produce significantly different results. The benefit of a control group would have been added data as to whether the results were treatment effects or a function of individual or family factors, especially in the context of students and families self-selecting into the program. A quasi-experimental method (participation or non-participation, a control group, by classroom for example) could help establish more cause-effect relationships without random assignment.

An additional limitation is that it is unclear whether there are any significant differences between the participating and non-participating families. For example, participating students had a high pre-program average total score in the STEM Career Interest Survey; it is unclear whether this would also have been true for non-participating students. A final limitation was the brief (4 h) contact between students and the role models at the fair.

While literature on best practices for exposing elementary school students to STEM role models is rather scarce, the existing literature suggests that the frequency of interactions between mentee and mentor is a key factor in the success of the relationship. Future iterations of this program should consider more extensive involvement of role models, for example, during the 8-week programming, for completion of specific STEM-related tasks or shadowing in the workforce.

Future Directions

This program is novel in that it addresses is a significant barrier to economic mobility in the Spanish-speaking Latinx community (i.e., the high attrition rates in STEM participation). With some adaptations (e.g., longer duration), this program can serve as a model for interventions in other schools or academic settings. A broader implementation of the program, potentially across similar (i.e., dual language) schools in the district, including control group, might help determine the viability and efficacy of the program. Because the intervention is delivered in the real-world setting of schools, some training of school staff may help with sustainability and broader dissemination of the intervention.

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Data Availability Data and program materials available upon request.

Declarations

Ethics Approval Approval was obtained from the University of Denver Institutional Review Board. The procedures used in this study adhere to the tenets of the Declaration of Helsinki.

Consent to Participate Informed consent was obtained from all individual participants include in the study.

Conflict of Interest The authors declare no competing interests.

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