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Exploring the Impact of a Spanish Language STEM Outreach Program on Participants, Families, and Mentors

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ABSTRACT: *Cena y Ciencias* (Supper and Science), or CyC, is a STEM outreach program for kindergarten through fifth-grade youth and their families. Monthly, university scientists lead interactive experiments with assistance from university student mentors. CyC is conducted entirely in Spanish. While youth complete activities, a separate parent session is held to explain the activities. The overall program goals are to increase interest in STEM careers and encourage Spanish-speaking youth that a scientist can "look like me." We conducted a descriptive, qualitative case study assessing the program's impact on participants, parents, and mentors. Youth participants and parents reported they liked the activities from CyC. Both youth and parents believe anyone can be a scientist. However, few students identified CyC teachers as scientists without further prompting. Neither youth nor parents connected attending CyC with the youth participant's future career. Mentors developed an appreciation of their bilingual skills as a positive identity within their science profession. Mentors expressed new appreciation for science outreach and future intent to do more outreach. All mentors felt CyC was a welcoming environment. Implications for all STEM outreach targeting young audiences include revisiting the connection between fun science activities and careers, confirming participants make the desired connections.

INTRODUCTION

As science, technology, and engineering innovation continues to advance our economy, the need for skilled workers in STEM professions also expands. Forecasting into the future, new and expanding occupations will continue to require more workers with STEM-related skills and degrees (National Science Board, 2019). Jobs in STEM fields are desirable. Compared to employees in other professions, workers in STEM-related occupations have higher wages and lower unemployment levels than workers in non-STEM occupations (National Science Board, 2021).

At the same time, inequality continues to exist in the representation of employees in STEM fields. While the number of Latinx and Hispanic workers across all STEM occupations has increased in the last ten years, these individuals remain underrepresented among workers in STEM-related professions – even more sharply in STEM careers that require a college education (National Science Foundation, 2023). At the same time, the number of 25 to 29-year-olds who have completed at least a high school degree is lower for Hispanic young adults when compared to all other race/ethnic groups (National Center for Education Statistics, 2022).

Researchers and policymakers persist in discussing and proposing solutions to the disparities in STEM-related occupation employee demographics. Various studies and reports discuss interventions and their attempts to increase interest in STEM careers among underrepresented groups, including those identifying as Latinx or Hispanic. A report by the Pew Research Center (2022) found that Latinx and Hispanic Americans believe that young people are not pursuing degrees in STEM fields because they find the subjects difficult, they lack access to the education needed to prepare for these fields, and they lack mentors to encourage their success. By

educating, encouraging, and exposing Latinx students at a young age to science in informal settings like afterschool programs, students and families can form their own opinions of science and work to overcome the perception challenges keeping them out of STEM careers (Roncoroni et al., 2021).

Outreach Programs to Boost Interest in STEM Professions. Before young people make their final career decisions that either include STEM choices or avoid STEM choices, it is essential to reach these young people with positive experiences in STEM. Out-of-school time STEM outreach programs for elementary and middle school children have proven successful in increasing interest in and attitude towards STEM activities and STEM careers (Ching et al., 2019; Higde and Aktamis, 2022; Timur et al., 2019), including those outreach programs explicitly targeted at underrepresented racial and ethnic minorities audiences (Brown et al., 2020; Hayden et al., 2011; Roncoroni et al., 2021) and females (Christensen and Knezek, 2017). STEM outreach programs for high school students have been linked to changes in participants' education and career choices (Bindis, 2019) as well as attitude changes (Vennix et al., 2018).

Acknowledging the disparities in the number of STEM workers identifying as Latinx and Hispanic, outreach programs for elementary and middle school audiences specifically target Latinx young people with STEM learning activities (Hayden et al., 2011; Roncoroni et al., 2021). These programs include goals associated with increasing interest in STEM degree programs and careers through fun activities. Although many programs provide recruitment materials in Spanish to attract parents and guardians in which English may be a second language (Milner-Bolotin and Marotto, 2018; Roncoroni et al., 2021; Yau, 2013) or include bilingual mentors for the participants to assist with translation (Lucero, 2021), few outreach programs seem to teach and lead STEM activities entirely in Spanish.

Underrepresented racial and ethnic minority students share that aspects of their identities or backgrounds may keep them from feeling like they fit in STEM careers, a concept termed social identity threat (Steele et al., 2002). Individuals that do not see anyone they can identify with in specific situations or careers, such as STEM careers that require college degrees, may feel aspects of their identity make them less valuable or less likely to belong. One intervention to address the concern among Latinx students in STEM degree fields is providing STEM professionals as mentors who share identities with the students (Hernandez et al., 2018). Other interventions include providing Latinx role models as speakers to high school classes or student groups (Hernandez et al., 2017), matching bilingual STEM degree college students with high school participants who may be interested in STEM fields (Lucero et al., 2021), and using an apprenticeship model in which students work in partnership with scientists on science projects (Hinojosa et al., 2021).

Mentors in STEM. Mentoring has long been included as a method to increase interest and self-efficacy in STEM degrees and career fields (MacPhee et al., 2013; Rahm and Moore, 2016). Mentoring, especially from a person that shares one's gender, racial or ethnic identity, is instrumental in young people finding and keeping an identity within STEM (National Academies of Sciences, Engineering, and Medicine, 2019). For the development of STEM identity, informal messages, such as from people with similar identities, are often more influential than formal programs teaching STEM (Sheu et al., 2018).

Within outreach programs, mentors who align with similar goals for teaching/mentoring are crucial for program success, especially for those programs targeted at historically marginalized individuals (Kupersmidt et al., 2018). Depending on the needs of the program and the needs of the individuals, mentors can take on different roles within the program. Rangel et al. (2022) describe four roles that mentors play in after-school STEM programs, including the roles of teacher, friend, supporter, and role model.

Parent Support. STEM college and career outreach to Latinx students often includes family events and family activities (Hernandez et al., 2018; Lucero et al., 2021; Milner-Bolotin and Marotto, 2018). Parents who support their children at home by recognizing their interest in science can assist in developing a young person's identity in STEM (Cian et al., 2021; Dou and Clan, 2021). Parent support is also necessary for youth to navigate the information and decisions that lead to STEM college degrees and careers (Shaby et al., 2021). STEM outreach activities that include information and activities for parents and families are linked to increased confidence for family members in discussing STEM topics with their children (Jones et al., 2019).

Cena y Ciencias as STEM Outreach Program Overview. *Cena y Ciencias* [Supper and Science], or CyC, is a STEM outreach program affiliated with the University of Illinois at Urbana-Champaign for children in kindergarten through fifth grade and their families, delivered entirely in Spanish. During monthly events, university STEM professors or graduate students lead interactive experiments with assistance from university undergraduate and graduate student mentors. The overall program goals are to (1) increase interest among participants in STEM majors and careers and (2) encourage Spanish-speaking youth that a scientist can "look like me."

CyC began in 2013, went virtual during the COVID-19 pandemic, and returned in person in 2022. The program occurs monthly, begins with a meal for all participants and their

families, and continues to the STEM activities. Participants are recruited from three Spanish and English dual-language immersion schools across two public school districts.

During the STEM activity portion of the program, the lead scientist begins with a leader-led demonstration of the activity or experiment that is the event's topic and an explanation of the scientific concept behind the activity or experiment. Next, students are divided into small groups and complete the activity or experiment with assistance from university student mentors. The university mentors are also present to help students process and reflect on the activities. While youth complete activities, a separate parent session is held to explain further what their children are experiencing and provide information to the parents that may help with discussions at home about the experiment. CyC is designed so that all explanations and discussions take place in Spanish. Included as a supplement are pictures of activities at past CyC events.

University student mentors are recruited primarily from the university chapter of the Society for the Advancement of Hispanics, Chicanos, and Native Americans in Science (SACNAS). The student president of SACNAS is encouraged to coordinate with the CyC coordinating committee. All university students who come to CyC are welcomed. The group includes students for whom Spanish is both a first and second language. While at CyC, they are matched with small groups of students to complete the experiential activities after watching the opening leader-led demonstration. CyC does not have a training program for their university student mentors; they often learn the science activities simultaneously as the youth participants.

The target audience for CyC includes two Spanish dual-language grade schools in the Champaign-Urbana community. All students enrolled in the two schools are invited, and participants include families for which English is a first or second language. Among the participating schools, demographics include students described by the state school report cards as between 14%-62% Hispanic, 12%-50% English learners, and 41%-51% low-income (Illinois State Board of Education, 2022). Before the pandemic, the program generally reached 40 families and 15 university student mentors monthly. During the pandemic, the number of participants attending virtual events decreased. Since the program began in-person programming again, participation has increased to levels similar to before the pandemic.

During the COVID-19 pandemic between spring 2020 and spring 2022, the CyC program met virtually using the Zoom video conferencing platform. In order to provide an interactive experience, participants registered ahead of time. They were given a take-home kit of supplies needed for the experiment and a list of everyday items that could be found in the household. During the CyC program, the lead scientist started the event and demonstrated the activity; then, participants completed the activity independently. Video capabilities allowed participants to share the results of their activities visually. For example, making ice cream, using UV lights on different objects, navigating the virtual Mars rover, and interacting with electricity.

CyC is led by a community collaboration of partners, including the university, school districts, and the Cooperative Extension Service. Each month a university professor or graduate student who speaks fluent Spanish is invited to share their research with CyC. The committee works with each speaker to ensure their research is interactive and understandable to a grade school audience, designed using experiential and inquiry-based learning principles.

Study Objectives. This work attempts to evaluate the impact of the CyC program on the participating parents, youth, and college-aged mentors. Using the CyC logic model outcomes as a framework, this study was guided by the following questions to determine the impact of attending the CyC program on youth participants, their parents, and the program's college-aged mentors.

1. Do youth *participants* in CyC identify knowledge, attitude, and action changes related to science activities and science careers from participation in the CyC program?
2. Do *parents* identify knowledge, attitude, and action changes related to supporting science activities and science careers for their children?
3. Do CyC *mentors* identify knowledge and attitude changes in the youth participants?
4. What other benefits does CyC volunteerism and participation provide for CyC *mentors*?

METHODS

Evaluation Overview. To evaluate the impact of the program model, we conducted a descriptive, qualitative case study (Creswell and Creswell, 2018) assessing the program's impact on youth participants, parents, and mentors. We use the program's logic model as the framework to analyze the connection of the program's activities and features to the program's stated outcomes (Yin, 2018).

In 2019, the CyC collaborators created a program logic model to explain their program and the outcomes they expected from the program design (McLaughlin and Jordan, 2015; Thomas and Campbell, 2021). The program had been in existence for six years prior to developing the logic model. The logic model is displayed in Figure 1.

The CyC logic model explains the program inputs and critical activities, namely the monthly afterschool programs and the planning partnership to develop the programs. While

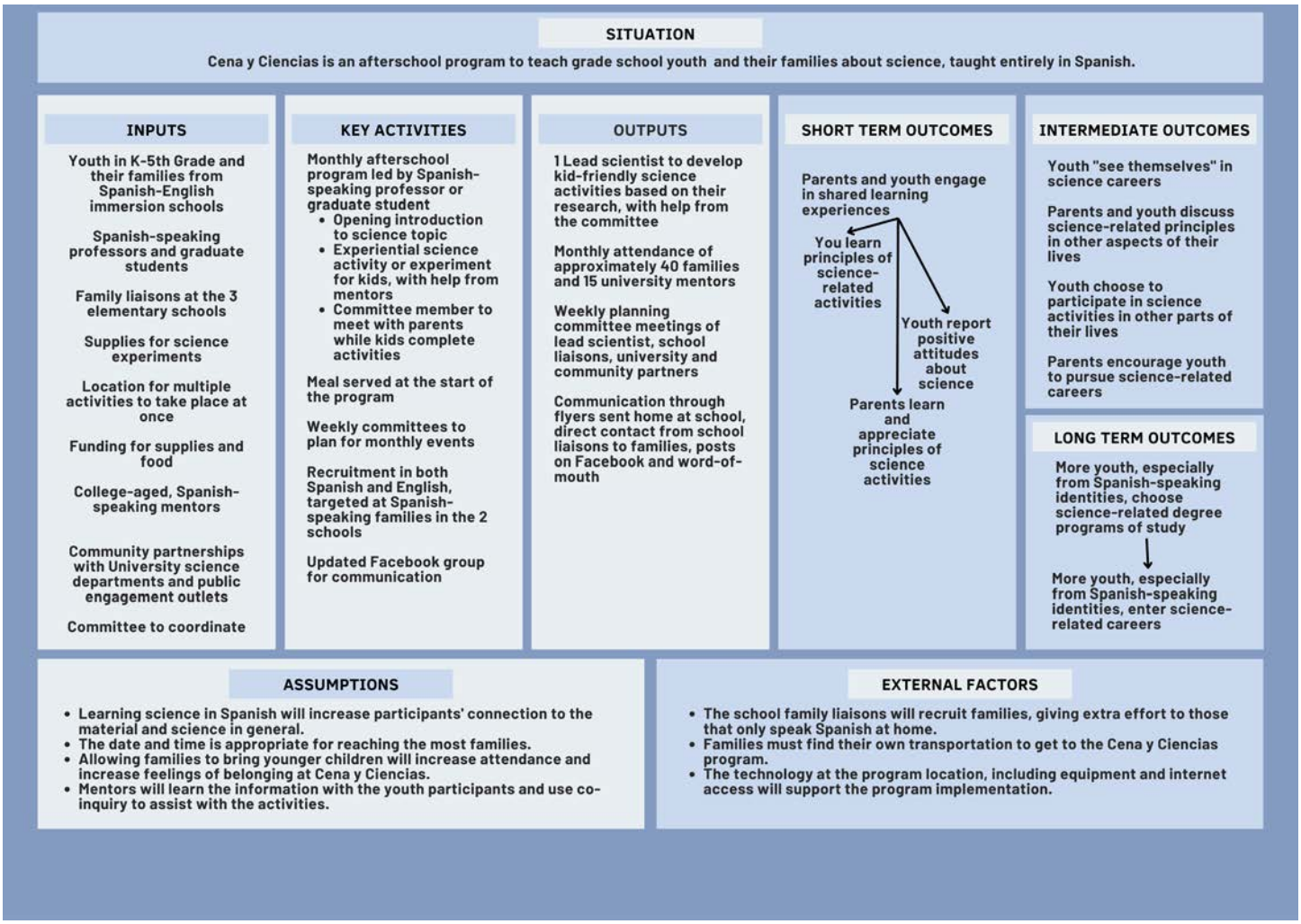

Figure 1. Cena y Ciencias Logic Model.

the program is open to all youth and families at the Spanish immersion grade schools, CyC primarily focuses on changing the perceptions of science and science-related careers for youth with Latinx identities. The components of this afterschool science program that make it unique from others are that 1.) the entire program is taught in Spanish and 2.) the instructors leading the science activities will serve as role models of Spanish-speaking, Latinx experts in science, which will give youth "someone like me" to emulate in science degrees and careers.

The program attempts to do this by engaging the CyC logic model, which outlines the program outcomes for the youth and parent participants. In the short term, youth participation in the CyC experiences will lead to youth and parents learning about science-related principles from the activities and youth reporting more positive attitudes about science activities. From these experiences and working with university faculty and student mentors, youth identifying as Latinx will be more likely to see themselves in science careers. They will also choose to participate in science activities in other parts of their lives. In addition, the experiences at CyC should lead to parents and youth discussing science-related activities in other aspects of their lives and parents being more encouraging of youth pursuing science-related careers. In the long term, youth participants will be more likely to choose science-related post-secondary programs of study and be more likely to enter science-related careers.

The original evaluation plan included a short survey when participants arrived at CyC, asking what they did to learn more about the previous month's topic or share the information they learned from the previous month. A longer survey was planned for administration at the year's last event. However, collecting additional information at the beginning of the CyC events proved too challenging, and the COVID-19 pandemic cut the programs short without the ability to reach participants with the survey. In order to still collect information, we pivoted to the current interview strategy to collect information from participants, their families, and mentors.

Interview questions for the youth participants and parents were developed around the specific aspects of the logic model to determine if they shared the same ideas, concepts, and connections about their experiences with Cena y Cien-

cias. For example, parents were asked, "What did your child learn from attending Cena y Ciencias?" and youth participants were asked, "What did you learn from attending Cena y Ciencias?" Questions for the mentors were developed to determine the mentor's perception of the knowledge and attitude changes they witnessed while volunteering with the program, as well as how they personally found the program impactful.

Participant Recruitment. We began recruitment for interview participants through the virtual CyC events held in the spring of 2021 and fall of 2022. The virtual CyC program facilitator provided interview recruitment information during the CyC virtual sessions and on the CyC Facebook page. During the first outdoor event held after the pandemic, one of the researchers attended and passed out flyers to the families about the interview opportunity. Individuals interested in being interviewed could send an email or a text message to the contact information on the recruitment flyer. Beginning with the participants identified through this recruitment method, we used a snowball or chain sampling technique (Merriam and Tisdell, 2016). At the end of each interview, we asked interviewees to identify other participant families or mentors to interview. The current interviewees were asked to contact the potential new participants and share the researcher's contact information. Interviews continued until all the potentially identified participants were contacted, and those that agreed to be interviewed completed their virtual interview. Assuming all interviewees made contact, six families and three mentors did not contact the researcher for an interview. Recruitment ended when all the potential families and mentors who agreed to participate were interviewed. All interviewees received a $50 e-gift card to their choice of Amazon, Target, or Walmart.

Data Collection. The semi-structured interviews were completed over the Zoom video conferencing platform. Participants were given the opportunity to complete the interview in either English or Spanish. Interviews with parents and their children were scheduled at the same time. Parents completed their interviews first and then passed the computer to their children to share their perspectives. Some parents stayed during their children's interviews, as was apparent by their comments picked up in the background of the recording, while some parents appeared to leave the room or did not make comments recorded in the transcripts. The first few interviews conducted in Spanish were directly transcribed into English by one of the researchers from the audio recording. Subsequent interviews were transcribed from Spanish to English using an automated transcription service and then edited for accuracy by the researcher. Interviews conducted in English were transcribed initially using the Zoom transcription function and edited for accuracy by the researchers.

Data Analysis. The interview data for each group of interviewees (mentors, parents, and youth participants) was analyzed independently using an initial or open coding process (Saldana, 2016). Two researchers coded each of the interview groups. The mentor data was analyzed using MAXQDA, and the parent and youth participant data was analyzed using Dedoose. All names were changed to pseudonyms to protect the identities of the participants.

For each set of interviews, the two researchers coded the same interview and compared their codes, coming to a group consensus on code names and definitions (Saldana, 2016). The remaining interviews were then divided and coded using the agreed-upon coding terms. The researchers met regularly during the coding process to compare and discuss emerging codes to add to the codebook. A second and third rounds of coding followed to delve into specific themes identified through the analysis process and identify representative quotations. The final analyses of the parent and youth participant interviews were compared to determine similarities and differences between descriptions of how each group experienced the aspects of the CyC program connecting the logic model.

RESULTS

Youth Participants and Parents. A total of 9 families (11 parents and 13 youth) participated in the interviews. Different levels of demographic information were collected from each group. Their demographic summaries are included in Table 1, and a detailed description of each family is included in Table 2. All families except for one were participants in CyC for face-to-face activities. Therefore, they experienced the program when it was in its face-to-face format. Families were asked for their number of years of participation in CyC. However, they did not always have a clear answer. Most had an approximate number of years of attendance.

Youth Participant and Parent Findings. Analysis of the youth participant and parent interviews led to seven main themes related to the youth participants' knowledge, attitude, and action changes, as explained by the youth participants (evaluation question one) and their parents (evaluation question two). The themes are summarized in Table 3, in-

Table 1. *Youth Participant and Parent Interviewee Demographics.*

Category	Parents	Youth Participants
Gender	8 (73%) female 3 (27%) male	6 (46%) female 7 (54%) male
Ethnicity	4 Latinx 3 Mexican 1 White 1 Argentine/Paraguayan 2 Undisclosed	5 Latinx 4 Mexican 2 Mixed; White and Argentine/Paraguayan 2 Undisclosed
Language used in Interview	6 (55%) Spanish 5 (45%) English	8 (62%) Spanish 5 (38%) English

Table 2. *Youth Participant and Parent Interviewee Detailed Description.*

Family Pseudonym	Family Interviewee Pseudonyms and Ages	Number of Years at CyC*	Identities
Houston	mother, father, two sons (Tommy 8 and Diego 6) and daughter (Roberta 10)	5	Mexican, speak Spanish at home
Rodriguez	mother and son (Joseph 9)	2-4	Latinx, speak Spanish at home
Wasson	Mother, daughter (Daniela 10), and son (Zeke 8)	4	Did not disclose
Carrera	mother and son (Carlos 11)	5	Mexican, speak Spanish at home
Anton	mother, father, daughter (Miriam 10) and son (Ivan 7)	5	White and Argentine/ Paraguayan
Mendez	mother and daughter (Harper 9)	4	Latinx
Romero	mother, daughter (Meredith 8) and son (Andre 6)	1 (attended only virtually)	Latinx, speak Spanish at home
Beltran	mother and daughter (Julia 8)	1 (attended in person)	Latinx, speak Spanish at home
Toby	father	2-3	Speaks some Spanish at home, did not disclose ethnic identities

Not everyone could identify an exact number of years attending Cena y Ciencias.

cluding a definition of the critical phrases defining them and the specific interviewees who included these themes in their interviews. A more detailed description of each follows.

STEM Activity Enjoyment. **Both youth participants and their parents shared that they enjoyed the activities at Cena y Ciencias and discovered new information about STEM topics from their program participation**. Increased interest in STEM topics often relates to participants' satisfaction with the program's STEM activities (Zhou, 2020). While interviewees used different ways to show their enjoyment of the CyC lessons, four of the thirteen youth participants described CyC as "fun" and notably, five out of the eleven parents commented on how their children thought the program and activities were "fun" as well. Youth participants talked about having fun with the activities and enjoying the activities with friends.

Both interview groups discussed positively that CyC provided youth participants the freedom to learn, explore and experiment with the activities. Participants could try new things, even experimenting in ways different from the official instructions of the activities. Youth participants who were part of virtual programming discussed trying different experiments with the leftover supplies in the take-home kits. Interviewees did not have a consensus on topics that youth participants or their parents particularly learned or enjoyed. Over the year prior to the pandemic and during the pandemic programming, each session of CyC was a different STEM topic, often moving across different science disciplines within a year's program. In addition, attendance at the virtual CyC program had decreased compared to the in-person program before the pandemic. The different topics and attendance may account for the varied content responses, with different interviewees attending and remembering different session topics.

Both youth participants and their parents described the utilization of science inquiry principles. In recounting an interaction between one of the youth participants and their family members, a parent shared their fascination with their

Table 3. *Youth Participant and Parent Interview Themes Related to Cena y Ciencias Outcomes.*

Theme	Key Phrases Defining the Theme	Parent Responses (n=11)	Youth Responses (n = 13)
Enjoyed CyC Activities	fun, entertaining, enjoyed, excited, like, want to go	7; Margaret, Mia, Karla, Cassandra, Jenna, Toby, Mindy	6; Miriam, Zeke, Daniela, Carlos, Julia, Joseph
Discovered New Information about STEM Topics	learned new things, learned how to, I didn't know before, I never thought of before	4; Margaret, Lupita, Jenna, Nico	6; Carlos, Roberta, Tommy, Ivan, Miriam, Harper
Doing more science activities at home	Cited examples: nature walks, museums, building and taking apart things at home, science kits, field/family trips	6; Karla, Toby, Mia, Miguel, Nico, Margaret	6; Harper, Carlos, Ivan, Miriam, Roberta, Tommy
Able to identify Cena y Ciencias volunteers as scientists	A scientist is the one who tells us about the experiments at dinner and science.; No. well, you guys [people affiliated with Cena y Ciencias].	N/A*	2; Carlos, Roberta
Believe they can be a scientist	anyone can be a scientist, I would have to work hard but I could be, I think so, maybe	N/A*	13; all
No connection between the CyC program and future science career goals	Interviews included careers not covered by CyC such as a veterinarian, a chef, mechanic, doctor, inventor, archeologist, and engineer.	N/A*	6; Harper, Carlos, Miriam, Tommy, Daniela, Zeke (all mentioned careers in science fields but not related to careers mentioned in CyC)
Changed view/idea of science	Well, I realize more things that maybe I didn't know so much about; has it changed no, but amplified yes; was more clear on certain topics, more tangible, value scientists, sees science as hard work	4; Margaret, Miguel, Lupita, Mindy	4; Joseph, Daniela, Tommy, Diego

Question not asked to parent interviewees.

child's willingness to confront and combat misinformation in conversation. This child's actions to ensure the correction of information align with the scientific principle of the integrity of knowledge. Another example of our participants practicing science principles involves the parents' growing openness and objectivity to new information and changes in their definition of science.

> *We have relatives or friends who do not want to get the vaccine, and they say no, but they are the instructions for your body. So it's like that fascinates me, because I say like, like something like that, even if I hadn't been in science I wouldn't have said something like that, it wasn't like no, well who knows they're giving you this, but I think that has been a very positive thing.* (Mia, Parent)

> *It's been really great to learn about the variety of ways that you know, especially this year. Some of the scientists guests that type of career paths, they have it's been really interesting to me to learn about how they've used their science degrees.* (Jenna, Parent)

Science Activities at Home. **Youth participants and parents described doing more science activities at home**. Responses included a mix of Cena y Ciencias-related activities and other activities. When asked if they did science-related activities at home, youth participants were more likely to talk about completing activities they learned at CyC, like making slime and mixing ice cream. Their answers also included references to unrelated science projects or experiments they completed at home, such as cooking and measuring ingredients, doing science "stuff" from YouTube, and reading science-related books. As mentioned, one youth participant talked about using leftover pieces from their virtual CyC kit to do new and different activities at home.

In contrast, parents were more likely to describe science at home in terms of family activities, including family science-related field trips, visiting wind turbines, visiting a museum, hiking, or watching science videos on YouTube. Parents also discussed providing their children with science resources such as books or science kits. None of the parent interviewees talked about connecting the activities from CyC to other science activities, trips, or discussions at home. Most parents mentioned science activities more aligned with the family's or the children's interests than with topics learned at CyC events.

> *So we used to go to…children's museums like all the time. Everywhere we go and we try to travel, we do a lot of hiking. We don't camp a lot, but we definitely do hike and seek outdoor experiences. We purchased them like science kits where they have little experiments to do at home or make things together.* (Karla, Parent)

> *I like to do really fun experiments like slime that includes science where it's like polymers and I also like to do like the experiment where you mix vinegar and baking soda and cause a chemical reaction. I like to do small experiments like that.* (Harper, age 9)

Ability to Recognize Science Professionals. **Cena y Ciencias youth participants did not readily identify that they knew a scientist**. When asked specifically if they knew a scientist, youth participants mentioned friends of friends or famous scientists. Only two of the thirteen youth participants identified the CyC teachers as scientists they knew without further prompting. When asked directly if they would consider the CyC teachers as scientists, most agreed; however, it is important to note that in an interview about participation in a science outreach program, the youth participants did not initially think about the program leaders as scientists.

> *"A scientist is the one who tells us about the experiments at Cena y Ciencias."* (Roberta, age 10)

> *"My grandmother's friend. She used to work at my friend's dad's university. And he's a scientist."* (Miriam, age 10)

> *"There's Isaac Newton, Einstein, Marie Curie, Benjamin Franklin, Tesla."* (Carlos, age 11)

Ability to Become a Scientist. **Youth participants believe they can be a scientist, both as a career goal and informally as a means of exploring their world**. Some youth participants explained that they could be scientists because they could be anything they wanted to be. Others talked about working or studying to become a scientist. Either description seemed to interpret the question to mean that being a scientist is a career choice and a career choice open to everyone. Their descriptions of a scientist's job included experimenting, inventing, and learning. The youth participants did not talk about specific kinds of scientists or specific science topics related to the CyC activities and the CyC teacher fields of study. While agreeing that they could be a scientist, other youth participants explained their answer as everyone who wants to understand, experiment, or learn new things is acting as a scientist. In this interpretation, a scientist is more a personal characteristic than a career goal.

While none of the youth participants discussed barriers to becoming a scientist, one parent felt that the worldview of science as a career has changed since she was a child to now. While she felt challenges to becoming a scientist, she felt her child did not hear the same messages about the barriers to science as a profession. However, messages are more open to encourage everyone to be a scientist.

"*Because everyone can do what they want to do. Yes, everyone can be a scientist.*" (Tommy, age 8)

> *It's different than the perception that I had when I was his age, a lot different. He started to see it as something possible. When I was a little girl, I heard the word scientist and I imagined someone like Albert Einstein, something that I wouldn't do because I don't have that intellect.* (Margaret, Parent)

Future STEM Career Goals. **Neither youth participants nor parents connected attending Cena y Ciencias to the youth participants' future career goals**. Youth participants did not use the word "scientist" when discussing their career goals. Even after being asked if they could be a scientist, the word scientist was not mentioned when youth participants discussed their own career goals. Some of the youth participants had science-related career fields, like archaeology or inventing, but the careers were unrelated to any of the CyC activities or the specialties of the CyC professors and graduate student teachers. While some interviewees would connect the sponsoring university to the CyC program, most did not discuss themselves attending the sponsoring university for a degree or career in science. Three parents, however, did state their children's or families' wishes for their children to attend the University of Illinois. Two of the three shared that this interest was likely due to proximity to the families' residences or influence from family members currently attending the university. Even so, one parent mentioned their child's interest in attending the university to pursue a degree in veterinary science. While this was not a topic covered in the CyC program, it was the only STEM degree explicitly mentioned in relation to the university.

Table 4. *Mentor Interviewee Demographics.*

Category	Mentor Descriptors
Gender	5 (42%) male, 7 (58%) female
Ethnicity/Race*	3 Latinx, 3 Mexican, 2 White, 1 Asian, 1 Colombian, 1 Korean, 1 Puerto Rican, 1 Peruvian*
Native Language	6 (50%) Spanish is their native language
Highest Level of Education	8 (75%) PhD
Location of Undergraduate Education	4 (33.3%) university outside of the United States 8 (66.7%) United States university
Mentoring in Spanish	6 (50%) first-time mentoring in Spanish
Years as Cena y Ciencias Mentor	Average 2.25 years

**Individuals were asked to describe their race and ethnicity. Some used more than one descriptor.*

"I sort of want to be an archaeologist. Or artist. Or maybe even like an inventor." (Harper, age 9)

"Mechanic. Yes. And a veterinarian too." (Carlos, age 11)

"Well, actually, I do want to be like I want to be a doctor, but I also want to be. Like a decor person. Yeah, like a designer." (Miriam, age 10)

Mentor Findings. In total, we interviewed 12 CyC mentors. All the mentors were students at the host university when they volunteered with CyC. Some mentors were recruited from the student chapter of the SACNAS, as mentioned previously. Others were Spanish language majors or minors recruited through marketing materials sent to their degree program as an opportunity to practice speaking Spanish in a new setting. Many mentors had finished their time volunteering with CyC and studying at the host university at the time of the interviews. All interviewees were mentors with CyC prior to the COVID-19 pandemic, volunteering at the face-to-face program. No mentors were used during the vir-

Table 5. *Mentor Interviewee Detailed Descriptions.*

Pseudonym	Mentor Descriptions
Micheal	Male, White and Korean, PhD in Microbiology, first time mentoring in Spanish, 6 years with CyC, no outreach experience but had experience mentoring in science
Celia	Female, Latina, PhD in Microbiology, undergrad at Cal State University, 2-3 years with CyC, first time teaching in Spanish, not first time being a science mentor, had experience in high school
Pam	Female, White, BS in Psychology and Spanish, 1 year with CyC, First time mentoring in Spanish, mentored for 2 years
Edgar	Male, Mexican, postdoctoral at OSU, PhD in Nutrition, BS in Chemistry, Native language is Spanish, Bachelor's degree from university in Mexico, >1 year with CyC, taught at a bilingual school in Mexico
Gaby	Female, Mexican, PhD in Chemistry, BS from UC San Diego, first time mentoring in Spanish, has mentored previously, 1 year with CyC
Jade	Female, Latina, PhD in Chemistry, Native language is Spanish, first time mentoring in Spanish, has mentored previously, 3 years with CyC
Angela	Female, Asian, BS in Molecular and Cell Biology, had previous informal mentorship experiences, 3 years with CyC
Benito	Male, Puerto Rican, PhD in Physics, Bachelor's degree from university in Puerto Rico, native language is Spanish, not first time teaching in Spanish, 5 years with CyC, had previous experience mentoring
Ivy	Female, Colombian, Graduate degree in Physics, first time mentoring in Spanish, 3 years with CyC, first time mentoring
Albert	Male, Peruvian, Graduate degree in History, Bachelor's degree from university in Peru, native language is Spanish, not first time mentoring in Spanish but first time mentoring bilingual, <1 year with CyC
Rosalia	Female, Latina, PhD in Materials Engineering Science, native language is Spanish, first time mentoring bilingual,1 year with CyC, not first time mentoring
Romeo	Male, Mexican, Post doctorate in Optical Engineering, Bachelor's degree from university in Mexico, native language is Spanish, experience mentoring in Spanish, 2 years with CyC

tual programming.

Table 4 describes the demographic identities of the mentors. Table 5 includes each mentor's general description, detailing each individual's different identities.

Two researchers coded the mentor responses using two rounds of open coding and consensus-building conversation to reach agreement on codes. Four themes related to the experiences at CyC were developed. The themes most prominent from the mentor interviews did not have to do with the participant outcomes as derived from the program logic model but from the impact mentoring with CyC had on the mentors themselves. Table 6 includes the themes devised from the interview codes, the key phrases from the interviews used to define the codes, and the mentors responding to each theme.

Feeling Welcome at Cena y Ciencias. **All mentors, regardless of their identities, background, or roles, felt welcome at Cena y Ciencias.** Mentors who spoke English as a first language or English as a second language, as well as mentors with a background in science or another degree area, felt welcome at CyC. The atmosphere was described as inclusive, and everyone perceived being treated equally. Some mentors even talked about being busy with their schoolwork and not wanting to go to the CyC event, but after they went, they were always glad they did.

> *You know, scientific experiment demonstration type things and undergraduate, but that was always in English, but Cena y Ciencias, it was really nice that it was in Spanish that's my native language so that was. It hit home for me. It was exciting, like it is very much something that I wanted to do.* (Jade, Mentor)

> *And I feel like Cena y Ciencias was sort of like an oasis to be like no, like actually being bilingual is an advantage is something that you should be proud of, and I sort of started to be more conscious about how I taught the next generation and how I like imparted certain values or certain, I don't know, I was more mindful about trying to make them feel like more empowered by being bilingual or by speaking many languages.* (Edgar, Mentor)

Speaking Scientific Spanish. **Speaking scientific Spanish increased positive feelings about one's identity as a Spanish speaker in a science profession**. CyC helped mentors to see their bilingual skills as a positive trait of which they should be proud and not ashamed. Speaking Spanish and the process of learning and teaching science in Spanish was a powerful experience for many mentors that changed their self-perception and re-defined their identity. Their experience with CyC left them empowered to teach youth in Spanish and encourage Spanish-speaking youth to engage in science, encouraging bilingual youth to embrace their dual languages and see it as a strength.

Table 6. *Mentor Interview Themes related to Cena y Ciencias Experiences.*

Theme	Key Phrases Defining the Theme	Mentor Responses (n=12)
Felt welcomed at CyC	show support, inclusive, embrace others, no one made me feel different, kid excited to be there with the mentors	7; Jade, Edgar, Micheal, Angela, Ivy, Romeo, Pam
Speaking scientific Spanish increased positive feelings about one's identity as a Spanish speaker in a science profession	showing (representation) when speaking Spanish, know more Spanish than I give myself credit, empowered, advantage, see bilingual as a positive identity, more confident	9; Edgar, Ivy, Romeo, Angela, Celia, Pam, Gaby, Jade, Rosalia
Appreciation for science outreach	Value of education to youth and communities, representation, continued interest/ involvement in Science Outreach, connecting to younger generation through science interest	10; Micheal, Angela, Celia, Edgar, Gaby, Jade, Benito, Ivy, Rosalia, Romeo
Speaking Scientific Spanish was motivational to continue volunteering with the program	Think about how to improve science communication in Spanish, learning term translation, increase science literacy in Spanish, communicate with relatives about science in Spanish, communicating science in Spanish is applicable to own research or future career goals	4; Jade, Celia, Gaby, Ivy

> *I started to think about being bilingual more as a tool, or as an advantage, rather than it being like a shameful thing.*(Edgar, Mentor)

> …[E]*specially with the Spanish speaking students, I remember just wanting them to feel empowered by their language ability by their knowledge by their critical thinking.* (Angela, Mentor)

Appreciation for Science Outreach. **Cena y Ciencias volunteering led to an appreciation for science outreach and making science fun for kids**. Mentors described CyC as an experience that allowed them to recognize or remember that science can be accessible to children and communities. This concept is not always prevalent in graduate-level collegiate science education, from their experience. One mentor discussed the attempt to convince their research advisor that participation in CyC was important and worth the time. Mentors shared that the goal of CyC was showing kids that science could be fun. This was especially important for mentors who grew up outside of the United States. Two mentors discussed plans to replicate the CyC program where they

were currently studying or working outside of the CyC university community.

Along with the appreciation for science outreach came an expanded definition of science. Before CyC participation, mentors described their definition of science to revolve around their specific scientific disciplines, such as biology, chemistry, or physics. After participating in CyC, mentors included mentorship and outreach as part of their definition and saw science as a more encompassing concept. They felt that in an informal, out-of-school time setting, science could be fun and accessible, especially when there is no test involved.

This appreciation for science outreach also recognized that outreach, teaching science, and teaching science in Spanish were more difficult than they had assumed before volunteering with CyC. Mentors also shared greater respect for outreach activities and the time and effort it takes to create these programs.

> *I think it also really showed me how much work it is. It's made me I think a little more realistic about how that's going to affect time I was maybe not able to put into graduate school.. so I think being realistic about the time it takes* [to do outreach activities] *but also being optimistic that I have learned a lot of the tools to maybe create another program like that* [where I live now]. (Michael, Mentor)

> *You don't have to be a formal scientist in a white lab coat in order to perform science that can be done, you know from a young age and be able to instill that passion and interest in the kids. I think it was one of the biggest driving forces.* (Angela, Mentor)

Reasons to Continue to Volunteer. **Speaking Scientific Spanish was a primary reason mentors continued to volunteer with Cena y Ciencias**. The CyC outreach program provided an opportunity to speak in Spanish, specifically about science topics. Many mentors had not had the opportunity to talk about science topics in Spanish either previously or currently during other opportunities related to their work and studies. They appreciated the opportunity to use Spanish in conjunction with science topics.

Mentors also expressed the challenge that many scientific words were only in English and had no translation into Spanish. Even mentors who had studied science in Spanish were surprised that so many words were not easily translatable. This seemed to increase the desire of many mentors to continue to teach science lessons in Spanish, sharing this view of science with others.

> [I did] *scientific experiment demonstration type things in undergraduate, but that was always in English but Cena y Ciencias, it was really nice that it was in Spanish, that's my native language. It hit home for me. It was exciting, like very much something that I wanted to do. And also, it took a little bit of a learning curve, because all of my training, all of my scientific training has been in English, though, making the translation for technical words and like beaker and pipettes and those sorts of things.* (Jade, Mentor)

DISCUSSION

This case study discusses the impact of participating in a STEM outreach program led in Spanish on youth participants, their parents, and program mentors. While many outreach programs include science activities, family connections, and mentoring relationships, this program is unique in leading all components in Spanish. Results confirm that some program outcomes, such as opportunities for youth to learn and increase their interest in science, are prominent within the program. However, the results are not as supportive of the program increasing youth participants' interest in science careers or changing their perceptions of who can be a scientist. At the same time, interviews with the mentors revealed some interesting and powerful outcomes associated with identity as both Spanish-speaking scientists and outreach-focused scientists.

Science Knowledge Change. One of the overall outcomes of CyC is to increase interest in science and science careers. The program model includes three main components important to CyC. These components include 1.) engaging, experiential activities, 2.) science activities led in Spanish, and 3.) connections to role model scientists who identify as Latinx. Providing enjoyable activities is more likely to keep the attention of youth and is the first step in creating impact from participation. The quality of hands-on science activities is important in youth increasing their interest in science (Anderson et al., 2021; Holstermann et al., 2010), as well as the specific characteristics of the program activities (Vennix et al., 2018). Participants and parents reported that they liked the activities and would keep returning for more activities. The quality and delivery of the science activities seem to meet the needs of the participants to continue to join the monthly programs and lead to knowledge, attitude, and action change.

Participants and their parents also identified science knowledge gain. Both mentioned activities from CyC lessons that were new scientific concepts they had learned, which meets the short-term outcome of science knowledge gain. However, the interview data collected does not include specific numbers of CyC events or dates of attendance at CyC events. Therefore, we can not say that attending a cer-

tain amount of events or for a certain amount of years led to a more significant impact than attending for other amounts of time. Instead, this is a case study of the resulting perceptions from participants' memories of their experiences with CyC.

Completing Science Activities at Home. Both youth participants and parents also discussed completing science activities at home. Parents were more likely to talk about taking their children on science-related outings, while youth talked more about their experiments at home. While this is a demonstration of continuing science after the CyC event, not many of the mentioned activities were related to the CyC program activities. While most families had multiple years of participation in CyC, their answers seemed to be more about their current pandemic-focused situation. Therefore, they may have had different answers before the pandemic or after the new normal is found post-pandemic.

An interesting outcome of the virtual CyC activities was including "take home" boxes of supplies so participants could do the activities with the leader on the Zoom screen. Multiple youth talked about using the extra supplies in their box to further their experimenting after the CyC official experiment. The "take home" boxes provided participants with supplies at home that they did not have previously, and they did not take home during normal face-to-face CyC events. As CyC goes back to face-to-face, they will consider options to include "take home" versions of experiment supplies in order to continue the experimentation outside of CyC.

Aspirations to Science Careers. In the youth participant interviews, the youth did not seem to make the connection between CyC program participation and science as a profession. They were not likely to consider the leaders of CyC as scientists, even knowing they were completing an interview about the CyC program.

In a discussion of these findings with the CyC coordinating committee, the committee members acknowledged that their program model did not include the lead teachers or the mentors introducing themselves as scientists or the lead teachers discussing precisely how the CyC activity is related to work in the lead scientist's lab. As with many outreach programs, it is assumed that youth participants will make the connection between the activities and future science activities. However, this may not be a valid assumption. Dou et al. (2019) found that childhood exposure to science activities did not impact STEM identity in college. Elementary-aged youth are still developing critical thinking skills and may need more direct information to connect science activities and careers.

While we do not know the exact reason youth do not directly link CyC contacts to scientists, we hope to explore future CyC events in which time for the scientist volunteers to introduce themselves and describe their jobs as scientists is built into the program.

At the same time, the term science is perhaps too generic in relation to STEM-related career descriptions. As a hypothetical question, how many doctors, chemists, or physicists would describe themselves as scientists? While doctors and the medical profession are classified as STEM-related occupations (National Science Board, 2023), not everyone agrees that doctors are scientists (Smith, 2004). The term scientist has changed meaning throughout the years (Ross, 1962) and perhaps may mean something different to the next generation. Our youth participants did not all consider "scientist" a career; to some, it was more of a personal characteristic describing the process of experimenting and inventing.

Perhaps instead of connecting science activities to scientists, each activity could be connected to different STEM occupations related to that scientific principle. For example, when completing a food science activity, a guided discussion could include discussing specific food science careers such as a Sensory Scientist, creating and testing new food products, or Quality Assurance Manager, determining food safety practices and procedures. However, this is an added step in the design and planning of the program and requires testing to see if it changes youth perceptions.

Identity and Outreach as a Spanish-speaking Scientist. Among the findings from this evaluation, one of the seemingly most impactful additions to the Cena y Ciencias model is the influence of the experiences of speaking Spanish on the mentors. The role of the mentor is only vaguely mentioned in the program logic model, and there as a support for outcomes focused on the youth participants. While youth participants did not hesitate to consider themselves scientists, the Latinx-identifying mentors discussed their challenges as Spanish speakers in their scientific fields and the empowerment felt from speaking about their specialties in the Spanish language. Yosso's (2005) theory of community cultural wealth discusses the value of speaking multiple languages and recognizing this as a strength rather than a deficit. Volunteering at Cena y Ciencias allowed mentors to consider their bilingual skills as the asset they are and not as a social identity threat. CyC can continue to build on this aspect of the program and include more opportunities for mentors to network and discuss their identities within their professions, perhaps adding outcomes related to the mentors officially to the logic model as a focus for future programming.

Not only did Spanish language science outreach impact the mentors' identities in STEM, but it also allowed them to expand their definition of their roles to include outreach. While mentors discussed the challenges in describing their volunteer work to advisors, they realized the work was important and worth their time. Cena y Ciencias allowed mentors to differentiate between talking about science with other

scientists and talking about scientists to the general public. Mentors saw the importance of this outreach, exemplified by two mentors discussing their plans to start similar programs in their current job or university locations.

Limitations. This case study provides valuable information about designing and leading STEM outreach programs. However, it does come with limitations. Most importantly, while the program model of Cena y Ciencias is to include both English and Spanish-speaking families, we did not interview any parents that only spoke Spanish. The Spanish-speaking families that attended the CyC events or were recommended for interviews did not contact the researchers. We believe these families were likely uncomfortable talking about their experiences with someone from the university with whom they did not have a developed relationship. Children of parents who do not speak English may have different ideas about science, scientists, and future career aspirations. We also do not know if providing science activities in Spanish is essential to Spanish-speaking parents' conversations about science with their children.

Our evaluation included interviews with current youth participants. As the youth participants mature and choose future careers, they may reflect on their CyC experiences and find those experiences more influential than they do at a young age. Perhaps interviewing alums of the CyC program who are now in high school or college would provide a different story about the lasting impact on science attitudes and aspirations.

Similarly, the interviews were conducted while CyC took place in a virtual setting. Even though the youth participants would have been part of CyC when it was held face-to-face, their most recent experiences were with the virtual program. From the child and parent interviews, it seems that CyC kept the engaging activities through their virtual programming. The take-home kits allowed the participants extra supplies to experiment independently after completing the CyC activities. However, the interviewer and the participants did not differentiate specifically between the face-to-face experience and the virtual experience, meaning we can not assume exactly which means of delivery the youth were thinking about during the interview.

Lessons for STEM Outreach Programs. The results of this evaluation did not necessarily prove the action changes of the Cena y Ciencias logic model effective. Youth participants and parents talked about learning about science and completing science activities at home; however, the interviewees did not seem to connect science activities in the program to science activities at home or seem to alter their perceptions of science as an occupation or future career aspirations from attending the program. The youth participants seemed to attend the program because it was fun. Many youth also saw science not as a profession but something that one does every day when they ask questions and experiment in their own environments. Science was often described more as an idea or a way to interact with the world, not as a specific career. However, one could argue how many people with careers in science actually consider their job as being a scientist. The interviewed mentors describe themselves by their specific majors as a microbiologist or a physicist, not a scientist.

Other STEM outreach programs based on activities for elementary-aged children should use these results as an opportunity to re-think their own program logic. As program directors focus on recruiting and retaining participants, it is easy to focus on providing a fun time that participants will enjoy and decide to come back again. However, is that "fun" connected to the specific goals of STEM majors and careers? Do the participants understand that the fun activities relate to STEM careers? Especially younger youth will not make the connections without clear communication. This connection is even more important as research shows that often by the time students are in high school, they have already decided if they like STEM career fields (Davis, 2020; Moote et al., 2020).

The program's value to Spanish-speaking mentors provides an opportunity to re-think the outcomes of STEM outreach programs. While the usual focus is on the participants' outcomes and the value mentors have to mentees, it is important to recognize the impact mentoring experiences may have on mentors. In the case of Cena y Ciencias, the program may not have strongly encouraged elementary-aged youth to pursue careers in science. However, it strongly influenced retaining graduate students in their STEM professions. Focusing on retention is just as powerful as recruitment as we work to increase diversity in STEM careers. Providing opportunities for mentors to assist with STEM outreach programs may have the added benefit of solidifying their own identities in their careers.

At the same time, the CyC program has a very loosely-structured mentor program. All college students who are interested in mentoring are allowed. There is no training in science or developmental relationships for the mentors. The mentors often reported that CyC was the first time they had worked with youth in an educational capacity. One of the results of this evaluative process is that the CyC coordinating committee will be working on both training for mentors and reflection time for mentors as part of the CyC program. We encourage existing programs that want to add mentoring to provide training about the program content and the importance of and safety for working with youth before including a mentoring component.

ASSOCIATED CONTENT

Supplemental material mentioned in this manuscript can be found uploaded to the same webpage as this the manuscript.

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ABBREVIATIONS

CyC: Cena y Ciencias [Supper and Science]; SACNAS: Society for the Advancement of Hispanics, Chicanos, and Native Americans in Science

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