Through Activating Rural Communities, Rural Teen Science Cafés Spark Interest in STEM

Report on the 2021 - 2022 Adult Leader, Teen Leader, and Attendee Surveys

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Highlights

- In 2022, data were collected from 11 rural communities across the United States that held Teen Science Cafés.
- Adult Leaders (n = 11) felt more comfortable, interested, confident, and capable of leading STEM activities after participating in the Teen Science Café Network.
- Teen Leaders (n = 24) reported statistically significant positive changes on all 9 STEM-related attitudes and 21st-century skills.
- Teens who attended multiple Café sessions (n = 230) reported statistically significant higher STEM engagement and identity scores than those who only attended one (n = 164).

Background

Geographic gaps in access to high-quality Science, Technology, Engineering, and Mathematics (STEM) learning experiences across the United States are apparent and have cascading effects in students' pursuits after they graduate. In examining a nationally representative sample of high schoolers, Saw and Agger (2021) found that "rural and small-town students were significantly less likely to enroll in postsecondary STEM degree programs compared with their suburban peers." Relative to urban and suburban areas, rural and small-town communities typically contain fewer college graduates, provide fewer job opportunities, and have more limited high-speed internet access (Carr & Kefalas, 2009; Hunter et al., 2020). Further, Saw and Agger's (2021) research showed that rural and small town schools' limited budgets and instructional capacities resulted in fewer STEM courses and extracurricular programs. Unsurprisingly, rural parents are the least likely to report that their child's after school programs offer STEM activities (Afterschool Alliance, 2021).

However, rural and small towns afford their own advantages that can fill this gap. For instance, students from these areas typically benefit from closer relationships within their family, school, and community contexts (Byun et al., 2012; Lyson, 2002). Rural out-of-school time (OST) programs may be able to leverage these close-knit relationships to positively influence learning experiences. As a result of this closeness, we might expect that these OST programs are particularly relevant and rewarding to youth (Hein, 2009) and meet the needs of youth who may not get adequate support or resources in school (McCombs et al., 2017). In these communities there is a growing movement of "Café style" OST STEM programs being offered that provide a casual social setting for teens, local STEM professionals, and adult leaders to come together, interact, and satisfy students' curiosities through lively interactions (Hall et al., 2021).

Teen Science Café Overview

A Teen Science Café is a free, regularly occurring event during the school year in which a local scientist, engineer, or STEM expert discusses their field experiences with the teen attendees. Ideally, a Teen Leader cohort, under the mentorship of an Adult Leader, organizes and implements each Café. Cafés usually draw a diverse crowd of local teens, and as such, they are "not just for science geeks; they are for all curious teens" (Teen Science Café Network, 2022).

With funding from the National Science Foundation (NSF), the Teen Science Café model began in 2007 in northern New Mexico. The Teen Science Café Network formed in 2012, after receiving additional NSF monies to support the scaling and adoption of the model into other communities. The Teen Science Café Network is a community of practice linking the various youth-serving organizations, institutions, community settings, and individuals that host Teen Science Café programs. As a community of practice, the Network offers resources, guidance, and support to its members so that they can effectively implement Teen Science Cafés, continuously improve Café experiences, and understand Café impacts.

Figure 1. Teen Science Café Core Design Principles

The Teen Science Café model has six core design principles that are continuously refined (**Figure 1**). Taken together, the Teen Science Café Network provides an infrastructure for teens to dig deeper into science through leadership skills, hands-on activities, and conversations. The Network aims to complement in-school learning by offering new perspectives on science and opportunities to build relationships with real scientists.

Data Collection

In the 2021–2022 academic year, the Teen Science Café Network collected data from their rural Café locations using PEAR's Common Instrument Suite – Educator Survey (CIS-E) and two formats of the Common Instrument Suite – Student Survey (CIS-S): the CIS-S retrospective pretest-posttest (RPP) and CIS-S posttest.

The CIS-E was administered to Adult Leaders twice: a baseline (pretest) before their professional development training and posttest following spring programming. The CIS-E is an educator self-report survey that asks educators about program context (e.g., where STEM activities are taking place), their views on their own and students' STEM identities, the ease of implementing practices aligned with high-quality programming, and their perceptions of change in their students' STEM confidence and STEM and social-emotional skills. Reliabilities for these scales are high, ranging from 0.74 to 0.94 (Allen et al., 2019; Price, 2018). Four additional scales were also included on this CIS-E that measured perceived Adult Leaders' STEM leadership and utilization of instructional practices related to fair treatment, cultural relevance, and growth mindset.

The CIS-S RPP was administered to Teen Leaders at the end of spring programming. The role of "Teen Leader" differed across Café locations. However, they included those who held formal leadership roles within the Teen Leader cohort at their location or attended four or more Café events. This CIS-S RPP was a 53-item youth self-report measure of four STEM attitudes (STEM career interest, career knowledge, engagement, and identity) and four social-emotional skills (critical thinking, perseverance, relationships with adults, and relationships with peers (Allen et al., 2020; Noam et al., 2020; Sneider & Noam, 2019). Reliabilities for these scales are high, ranging from 0.80 to 0.93 (Allen et al., 2019). An additional scale was also added to measure Teen Leaders' growth mindset.

Items were rated on a 4-point Likert scale from "Strongly Disagree" to "Strongly Agree." As a retrospective measure, Teen Leaders rated each item twice, according to how they felt before their Café and now ("today").

The CIS-S posttest was administered to Café attendees following every Café session. This CIS-S posttest was a 23-item youth self-report measure of two STEM attitudes: STEM engagement and identity (Allen et al., 2020; Noam et al., 2020; Sneider & Noam, 2019). Reliabilities for these scales are high, ranging from 0.91 to 0.93 (Allen et al., 2019). Items were CIS-S rated on a 4-point Likert scale from "Strongly Disagree" to "Strongly Agree."

Adult Leader Data Findings

Demographics

CIS-E pretest data included 15 Adult Leaders representing 13 communities. Nearly all (93%) of the Adult Leaders identified as women. The distribution of Adult Leaders' race and ethnic identities revealed that the majority (67%) identified as White, Caucasian (non-Hispanic). Other major race and ethnic identities were African American, Black (27%) and Latino or Hispanic (7%). The highest education level attained for the majority (73%) was a master's degree. The remainder (26%) was evenly split between bachelor's and doctoral degrees. When it came to prior experiences leading STEM programs, over a quarter (27%) reported no experience leading in-school STEM and two-fifths reported between 1 and 4 years of experience leading OST STEM.

Eleven Adult Leaders were included in the smaller posttest sample. Compared to pretest, it included higher proportions of Adult Leaders identifying as women (100%) and White, Caucasian (non-Hispanic) (73%); holding doctoral degrees (18%); and having had between 1 and 4 years of experience leading in-school STEM (36%) and 5–9 years of OST STEM (27%).

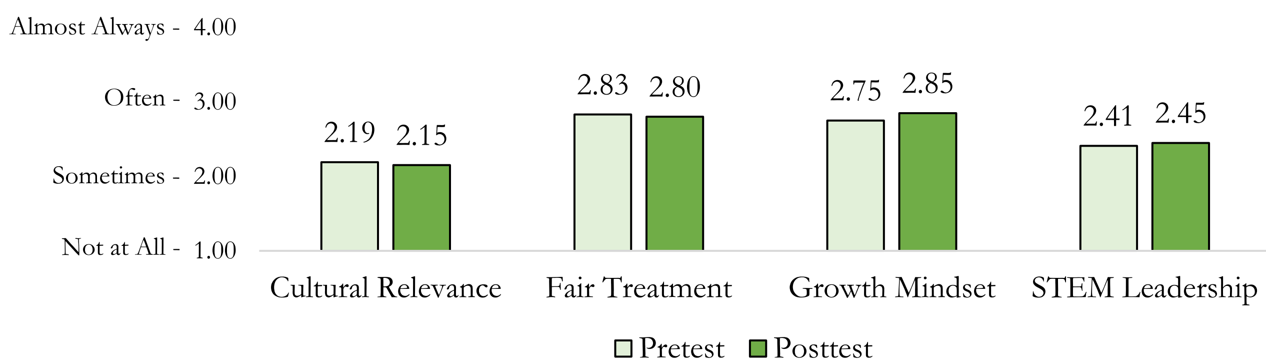
CIS-E Outcomes

Adult Leaders were asked how strongly they agreed or disagreed with four statements about their perceptions of leading STEM activities. They were also asked to rate the difficulty of implementing practices related to high-quality STEM programming. Of the 11 Adult Leaders who completed the posttest:

- 73% "strongly agreed" with feeling *comfortable* leading STEM.
- 82% "strongly agreed" with feeling *interested* leading STEM.
- 64% "strongly agreed" with feeling *confident* leading STEM.
- 100% "strongly agreed" with feeling *capable* of leading STEM.
- 81% indicated that they found using data for continuous improvement to be "somewhat" or "very" easy.

On average, Adult Leaders maintained their mean scores for Cultural Relevance, Fair Treatment, Growth Mindset, and STEM Leadership over time (**Figure 2**).

Figure 2. Mean Scales among Adult Leaders for Pretest (n = 15) and Posttest (n = 11), Teen Science Café Network, 2022



Rural Fellow Workshop Themes

In August 2022, 13 Adult Leaders known as "Rural Fellows" who led Teen Science Cafés in their rural communities during the 2021–2022 academic year convened for a two-day workshop in St. Louis, Missouri. PEAR attended this workshop to present on data and took notes on its major themes. The workshop's main goals were to share the Fellows' field experiences, including their challenges and successes; connect these observations with formal research findings; network and collaborate to further the Teen Science Café Network; and examine what worked with respect to the unique diversity and assets of the rural areas they represented.

During these sessions, some main themes that emerged in regard to the challenges they experienced were:

- **Schedule coordination issues:** Rural Fellows noticed that competition with other activities (e.g., athletics, jobs, social events, and homework) hampered their Café attendance rates.
- **"Rebuilding" after COVID-19 disruptions:** Because of pandemic-related disruptions, students had fewer opportunities to build leadership skills, making it more difficult to form Teen Leader cohorts at some sites.
- **A lack of resources:** The availability of central meeting locations, food, supplies, and transportation were inadequate in most communities. These resources were especially scarce in areas that were more significantly impacted by the pandemic.
- **Succession planning difficulties:** Rural Fellows expressed uncertainty that there were other adults in their communities that were willing and able to continue their Teen Science Cafés.

However, there were many successes that were celebrated as well:

- **Access to a network:** The Rural Fellows have established a community of practice in which they can share best practices and understand what others like them are facing in leading their Cafés. Having others to collaborate with was framed as invaluable for those coming from rural areas; one Fellow noted, "nobody in this room is in here alone."
- **Teen Leader cohort benefits**: Having a strong Teen Leader cohort was associated with increased Café attendance and improved teen leadership skills. It also provided a structure for teens to practice decision-making, agency, and ownership over their learning experiences. Rural Fellows who work with Teen Leaders shared suggestions for how others could build and sustain these cohorts.
- **Inspiring attendees**: Rural Fellows observed that introducing teens to local scientists served as a basis for connection, spread social capital, and expanded attendees' aspirations – making brighter futures possible within the community resources available.

Teen Leader Data Findings

Demographics

CIS-S RPP data included 24 Teen Leaders from six Café locations. One-third of these data came from the Southern Utah Café. Two-thirds of the sample identified as girls, over a quarter (28%) as boys, and the remainder (6%) as an unlisted gender. One-third were enrolled in tenth grade and a quarter in eleventh grade. Nineth and twelfth graders were equally represented in the sample (21% each). The vast majority (83%) identified as White, Caucasian (non-Hispanic). Other race and ethnicity identities included Asian, Asian-American (11%) and African American, Black (6%). A small proportion (6%) spoke a language other than English at home.

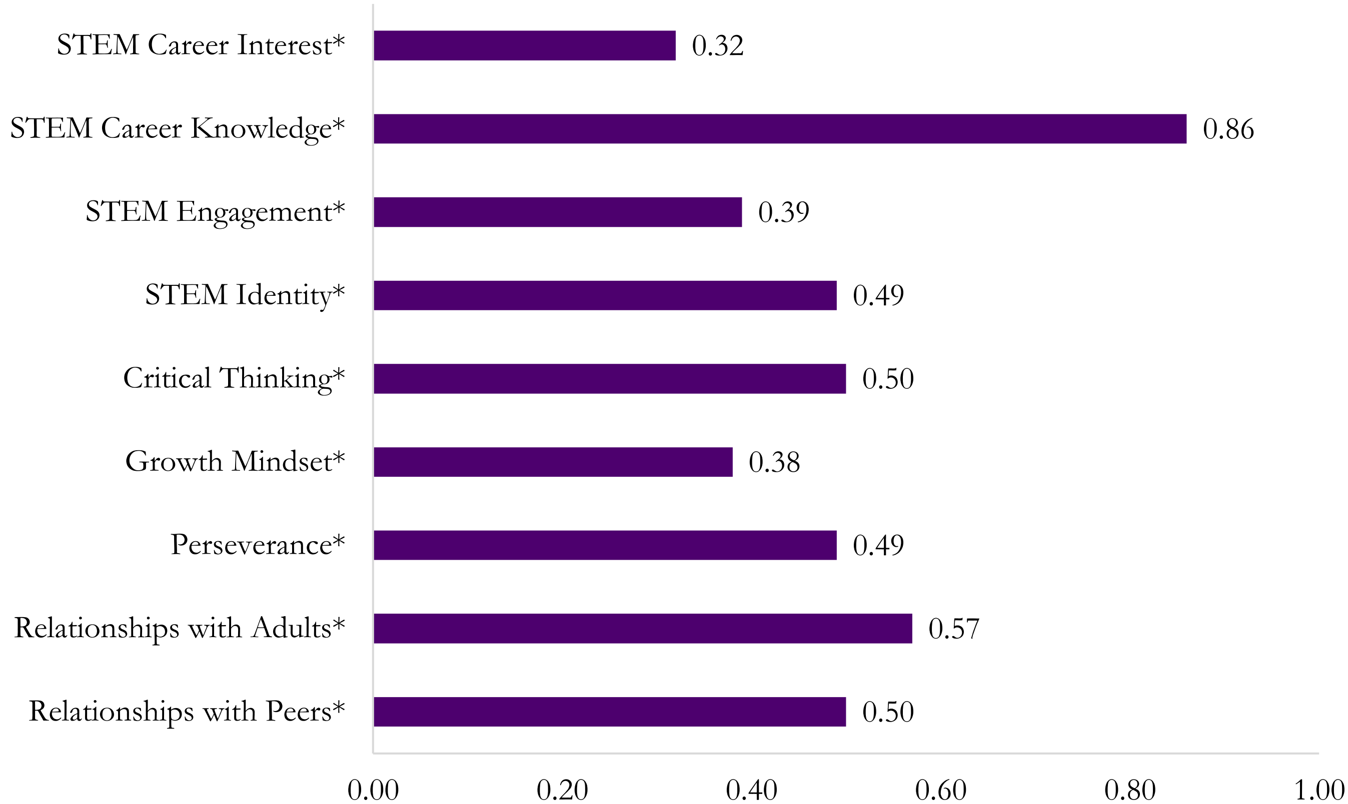
CIS-S Average Difference Scores

Difference scores for a given scale of the CIS-S RPP were calculated by subtracting its retro-posttest mean from its retro-pretest mean. Then, these difference scores were analyzed to see if they differed significantly from zero, which would indicate a change from pretest to posttest. Overall, we found statistically significant average difference scores (p's < 0.05) on all nine scales using a one-sample t-test (**Figure 3**). These scales included: STEM career interest, STEM career knowledge, STEM engagement, and STEM identity, plus critical thinking, growth mindset, perseverance, relationships with adults, and relationships with peers. All nine average difference scores were in the positive direction.

Attendee Data Findings

Demographics

Figure 3. CIS-S Difference Scores among Teen Leaders (n = 24), Teen Science Café Network, 2022



CIS-S posttest data included 394 responses from 11 Café locations. Because attendees completed the survey after each Café session they attended, there were many cases in which the same attendees completed multiple surveys. Therefore, the 394 responses in this sample do not represent unique attendees.

Table 1 summarizes the demographics reported in the entire attendee sample. The majority (63%) of attendees identified as girls, about one-third (36%) as boys, and one percent as an unlisted gender. Tenth graders comprised almost three-tenths (28%) of the sample. Ninth, eleventh, and twelfth graders were nearly represented equally (20%, 22%, and 19%, respectively). Middle school attendees in sixth through eighth grades made up a small proportion (12%) of the sample.

The distribution of attendees' race and ethnic identities revealed that the majority (70%) identified as White, Caucasian (non-Hispanic). Other major race and ethnic identifies represented were African American, Black (17%) and Asian, Asian American (8%). The remainder included: American Indian, Native-American, or Alaskan Native; Caribbean Islander; Latino or Hispanic; and those who preferred not to answer. Less than one-tenth (8%) spoke a language other than English at home.

Table 1. Attendee (n = 394) demographics, Teen Science Café Network, 2022

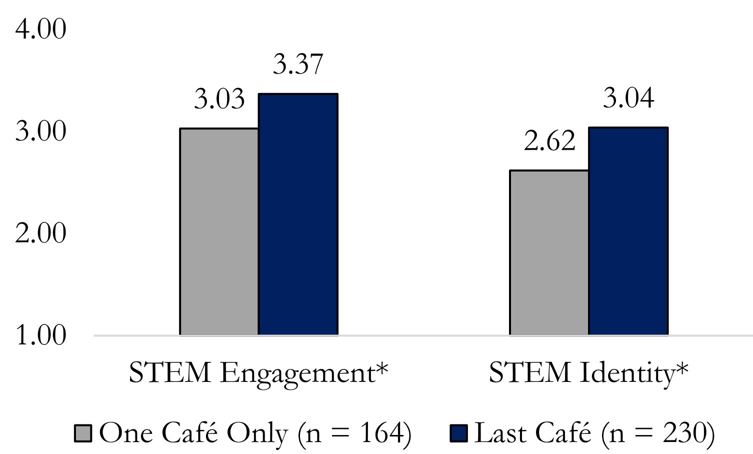
Variable	Sample size (%)
Gender	
Boy	128 (36%)
Girl	222 (63%)
Not listed	4 (1%)
Grade	
Sixth	14 (4%)
Seventh	21 (5%)
Eighth	12 (3%)
Nineth	76 (20%)
Tenth	107 (28%)
Eleventh	86 (22%)
Twelfth	72 (19%)
Race/Ethnicity	
African-American, Black	66 (17%)
American Indian, Native-American, or Alaskan Native	7 (2%)
Asian, Asian-American	29 (8%)
Caribbean Islander	2 (1%)
Latino or Hispanic	9 (2%)
White, Caucasian (non-Hispanic)	265 (70%)
Prefer not to answer	12 (3%)
Primary Language	
English	340 (90%)
Non-English	32 (8%)
Prefer not to answer	6 (2%)

Café "dose" was defined as the number of Café sessions each teen attended. Nearly 70% of the sample went to only one session. Over one-tenth of the sample attended two or three sessions (11% each). The maximum number of sessions attended was seven; however, this level of attendance reflects less than one percent of the sample.

CIS-S Outcomes by Café Session "Dose"

Café "dosages" were analyzed to examine whether attendees' average outcomes changed according to the number of sessions attended. To designate doses, attendees were first split between those who completed surveys for multiple Cafés (n = 230) and those who completed only one survey (n = 164). Those who attended multiple Cafés had their survey from their last Café analyzed. A one-way ANOVA f-test revealed statistically significant differences (p's < 0.001) between these Café doses for both STEM engagement and identity (**Figure 4**). Specifically, multiple Café attendees had significantly greater scale means at their last Café than those who attended a single Café. To examine the magnitude of these significant difference, we computed effect size for both scales using Cohen's d: STEM engagement ($d = 0.64$) and identity ($d = 0.81$). These effect sizes are considered a medium to large effect (Cohen, 2009).

Figure 4. CIS-S Attendee Outcomes (N = 394) by "Dose," Teen Science Café Network, 2022



Program Impact

In 2021–2022, Teen Science Café Adult Leaders were more comfortable, interested, confident, and capable in leading STEM learning experiences at the end of their yearlong community of practice than the beginning. At their Cafés, their confidence in using equitable and culturally relevant practices and in helping youth develop a growth mindset stayed relatively high over time. As made clear during the

Rural Fellow Workshop, these committed adults had the passion and drive to facilitate impactful Cafés in spite of numerous challenges.

Further, the Teen Leaders reported statistically significant positive changes on all nine outcomes measured on the CIS-S RPP. The Southern Utah Café represented the largest proportion (33%) of Teen Leaders. During the Rural Fellow workshop, their Adult Leader shared their best practices for establishing and utilizing a Teen Leader cohort: they offered the members of the local National Honor Society chapter Teen Leader roles as a means to fulfill their community service requirement. In turn, the Southern Utah group divided its sizeable Teen Leader cohorts into multiple subcommittees with separate purposes, one of which was the "Research Committee" charged with ensuring that surveys were completed. A Rural Fellow from this site noted that, "I think our attendance was better because we had such a big teen leadership committee, and everyone felt involved." Having opportunities to meaningfully contribute to their learning experiences likely enabled the positive outcomes observed among these Teen Leaders.

Looking at attendee findings, demographic data demonstrate that in these rural communities, the Network is reaching its goal of attracting teens with diverse life experiences. The outcome differences according to Café attendance levels were also notable because attending more than one Café had greater impacts on teens; continued Teen Science Café attendance rendered stronger results.

Although these findings are valuable, it is important to also consider their limitations. Youth who attended multiple Cafés might have thought they only needed to complete the survey once and, in consequence, the findings on dosage might have been influenced by this misconception. Also, these data only represent rural Teen Science Cafés. Without collecting additional data, the extent to which these results are generalizable in other settings is unknown. Including urban Teen Science Cafés in future data collection efforts would allow for such comparisons to be made and further develop the Network's research-base.

In sum, the rural Teen Science Cafés are a compelling example of how a network can support adult leaders so that they can engage teens from rural communities in STEM. Teen Leader cohorts are one strategy for effectively organizing the Café sessions and promoting youth voice. These findings also indicate that Teen Science Cafés can leverage interpersonal networks already available within rural communities, imparting promising impacts on STEM outcomes. Through continuous research efforts, the Teen Science Café Network is establishing a research-base to fuel future support to sustain, refine, and grow.

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Learn More

To learn more about the Teen Science Café Network, please visit their website.

To learn more about the data collection, interpretation, and reporting tools used in this report, please visit the **PEAR Inc**. website

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