

# Total Eclipse En Frontera

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The Total Eclipse en la Frontera program provided informal and formal science education outreach using Sul Ross State University's La Frontera Research Initiative (LFRI) mobile program, which serves communities located along the southwest Texas-Mexico border. With assistance from existing community partnerships, the Jay M. Pasachoff Solar Eclipse Mini-Grants Program, and the National Science Foundation Noyce program, our program reached over 20,000 people within a 6-month period. LFRI provided educational experiences to Uvalde CISD (4,041 students), Eagle Pass ISD (14,028 students), San Felipe Del Rio CISD (9,874 students), Southwest Texas Junior College (2,300 students), Sul Ross State University (2,071 students), and surrounding private schools, public libraries, and the general public. Established partnerships included the above institutions, as well as Presidio ISD, Marfa ISD, Alpine ISD, the Science Mill Museum, McDonald's Observatory, NASA's Marshall Space Flight Center, and the National Solar Observatory. Leveraging a mobile STEM Lab, LFRI provided eclipse-themed makerspace programming along with eclipse-focused educator training to include cultural total eclipse lectures with national experts to the communities along the southwest Texas-Mexico border. Specifically, border communities of Eagle Pass, Del Rio, Uvalde, and the Big Bend Region experienced STEM education outreach throughout the summer of 2023 leading up to the Total Eclipse in April 2024. Program outcomes provide a glimpse on the use of mobile makerspace program might increase STEM identity, self-efficacy, and engagement of isolated communities through a 2-year mentoring program connecting faculty, graduate students, preservice teachers, K12 educators, and community college students.

## 1. Introduction

Sul Ross State University (SRSU), a Hispanic Serving Institution (HSI), inherently serves underrepresented populations located in a vast and remote 19-county area of the Trans-Pecos region along the Texas-Mexico border. The Eclipse en la Frontera program aims to support remote Hispanic and Indigenous diverse communities using an informal mobile learning space to promote interest in eclipse science, STEM careers, retention, STEM identity, and self-efficacy in STEM fields while celebrating the 2023 and 2024 solar eclipse. The purpose of this project was to provide remote underrepresented communities access to informal learning activities designed to improve STEM literacy and enhance relationships between students, faculty, support services, collaborative partners, and other community stakeholders through a series of STEM informal learning workshops held with NASA, SRSU, University of Texas San Antonio (UTSA), Southwest Texas Junior College

(SWTJC), schools located in remote areas along the Texas Mexico border, and public libraries. This program was made possible by the generous contribution of the Jay M. Pasachoff Solar Eclipse Mini-Grants Program and the National Science Foundation's Noyce program. Objectives of the program include the following.

- **Objective 1:** Improve STEM identity of *underrepresented preservice educators and mentors* through increased self-efficacy as measured by a science career interest survey.
- **Objective 2:** Increase self-efficacy of STEM educators related to integrating technology in STEM content courses as measured by Christensen & Knezek ([Christensen & Knezek, 2017](#)) Technology Proficiency Self-Assessment for 21st Century Learning (TPSA).
- **Objective 3:** Improve scientific literacy in the *US -Mexico border communities* by inspiring curiosity in eclipse science as measured by an eclipse survey on the day of the eclipse.

The post-secondary institutions serving underrepresented communities along the US-Mexico border often lack strong STEM mentorship systems, with many students feeling culturally isolated in their STEM undergraduate programs. The eclipse presented a unique opportunity for us to address this problem by improving access for underserved communities along the Middle Rio Grande, including the communities of Eagle Pass, Del Rio, Uvalde, and the far remote communities near Big Bend National Park. Enhancing the relevance of STEM through stronger STEM programming that values Hispanic and Indigenous culture, language, traditions, and ways of knowing through a co-creation process could benefit underrepresented communities. A mentoring approach through “shared interactions, experiences, and mutual exchanges” could further assist STEM faculty in identifying culturally appropriate outreach strategies (([n.d.-a](#)), p 15). SRSU utilized collaborative partnerships through the National Science Foundation's Noyce en la Frontera program. The program provided a 2 year mentorship experience centered on culturally responsive teaching, the 5E model, and Universal Design for Learning. Both mentors and preservice teachers encouraged other educators to engage in participatory science activities related to the 2023 and 2024 eclipse events. Literature highlights the need to explore successful sustained mentorship programs on K12 teacher retention in math and science classrooms. Studies continue to demonstrate positive retention through longer mentoring initiatives over a two-year period, which has shown to benefit at risk schools by improving scientific efficacy and scientific identity, with students feeling as if they belong to a community of scientists (([Estrada et al., 2018](#))). The Eclipse en la Frontera program centered on increasing self-efficacy and STEM identity through a real-world event.



PI Dr. Jennifer Miller and Noyce Co-PI Catarino Morales with preservice teachers, Noyce scholars, and graduate students touring with the mobile STEM van March 2024.

### *Mobile makerspaces mitigate isolation issues in STEM*

The Eclipse en la Frontera addressed the fundamental question. How does informal learning centered around the 2023 and 2024 solar eclipse through mobile makerspace pop-up activities impact the self-efficacy of URM K12 educators, undergraduate students, and STEM faculty from isolated communities? Mobile makerspaces assist with building capacity beyond the university and assist with educator professional development around using technologies. They also assist with providing connections to engineering outreach and engagement ((Compeau, 2018)). The dynamic nature of makerspace activities may also help sustain faculty curiosity/intellectual growth through their inherent challenges. Mobile makerspaces offer strong internal outreach opportunities, with educators responding positively to professional development centered on digital and design literacies offered in a mobile makerspace environment, perhaps due to the creative and flexible approaches during pop-up activities. Mobile makerspace pop-up activities increase awareness and understanding of digital literacies in an active learning atmosphere ((n.d.-b)). This provides a mobile benefit to remote institutions serving URM communities. Digital literacies in mobile environments often incorporate creative mobile technologies, such as 3D modeling, fabrication, robotics, laser cutting, and lendable technologies. In addition to providing increased access, mobile makerspaces have been shown to positively connect to engineering outreach, thus increasing diversity within engineering education tasks

((Compeau, 2018)). Mobile makerspaces have been shown to excite diverse audiences but often lack robust participation in curricular models. Research needs to include how mobile makerspace curriculum approaches may improve participation through pop-up challenge layout and instruction and how those may foster participation beyond excitement to strong engagement ((n.d.-c)). *The Eclipse en la Frontera delivered STEM workshops from national experts using either a mobile lab or a makerspace classroom in which pop-up activities were customized to personalized expressions of interests and values, promoting higher engagement and interest. Educators serving the remote and isolated communities were offered the rare chance to grow by working alongside a mentor. In many cases, the mentor was an actual solar scientist.*

*Makerspaces provide an informal space for active learning outside of the classroom and facilitate self-directed learning opportunities for faculty development in which faculty collaborate with others to learn about digital resources and technology approaches to improve integration efforts in the classroom ((n.d.-d)). Makerspace environments provide a safe place for educators to participate in trial and error, experimentation of new technology tools, and patience when learning and investigating within a makerspace community ((n.d.-e)). The Eclipse en la Frontera program expanded upon PI Dr. Jennifer Miller's ((n.d.-f)) study that investigated the effect of professional development on educator perception around integrating technologies with STEM. Miller, Thomas, Maryboy, and Begay's ((n.d.-g)) program, funded by NASA, incorporated an Arizona makerspace mobile program to celebrate the 2017 eclipse. Both NASA-funded Makers' Guild studies incorporated 2D and 3D technologies during STEM makerspace pop-up activities. Participants reported a statically significant increase in self-reported competence in technology integration, the use of the World Wide Web, and Emerging Technologies for Student Learning as measured by the TPSA C-21 ((n.d.-h)).*

*The Eclipse en la Frontera program, in conjunction with the National Science Foundation's Noyce program, continues to support faculty development in STEM faculty mentoring by providing stipends to faculty enrolled in a mentoring program and stipends to mentoring interns who lead co-developed makerspace workshops. Over 11 Noyce scholars, 33 preservice teachers, and 7 faculty mentors participated in the project and served over 20,000 K-12 public school students during the 2023-2024 academic year. Several teachers were introduced to participatory science programs through the mobile unit with an emphasis placed on digital and STEM literacy development. NASA and the National Science Foundation's National Solar Observatory further assisted by bringing in engineers, solar scientists, and technology leaders with the aim of improving STEM identities and encouraging students to pursue a career in STEM. Scientists, mentors, Noyce scholars, and preservice teachers led multiple hands-on activities from the van with schools across the border region prior to the annular eclipse in October and also in the week leading up to the April 2024 total eclipse. These visits facilitated multiple mentoring opportunities for preservice and isolated educators, as well as for faculty to learn from the world's top solar scientists. An online registration process was launched in the Summer of 2023 for schools located in the path of totality to sign up for Fall and Spring mobile visits, encompassing a 120,000-square-foot area of Southwest Texas. SRSU utilized social media, email*

communication, and face-to-face visits to facilitate ten educator training sessions, which all shared the mobile makerspace STEM programming opportunity.

Noyce scholars and mentors began working on a 5E lesson plan in the spring of 2023 to host a 2023 Summer Let's Go Solar STEM camp for both educators for training that they then implement in a summer camp in the Uvalde, Texas, serving middle school students. The mobile program was utilized through the July 2023 camp experience. Scholars created pop-up activities to facilitate the "Elaborate" part of the 5E instructional model, including creating a make-your-own eclipse activity, making a living in space human food web and a solar oven, and facilitated several cardboard challenges, fabrication printing, and coding activities from the van. Scholars, mentors, and preservice teachers were fortunate to learn more about solar science from top scientists, including University of Texas - San Antonio's (UTSA) Angela Speck, UTSA's Lynsey Fuller, and Rice University's Patricia Reiff. Expanding programming to further support eclipse outreach required the PI to collaborate with several other stakeholders, to provide over 50,000 eclipse glasses to schools for both the annular and total eclipse, eclipse coloring books, and to expand a weather station unit to incorporate a telescope, Sun spotter, solar weather and eclipse mapping component along with additional crafts.

## 2. Makerspace Pop-Up Activities

Activities provided a hands-on experience to ensure Noyce Scholars and their mentors were equipped with eclipse science knowledge, digital skills, and dispositions to support learner success in mathematics and science in high-need school districts. All undergraduate and graduate students and many faculty participating in this program knew little about eclipse science and had never witnessed a total eclipse. Two sets of activities were created in the spring of 2024 to further facilitate eclipse outreach to young children, as well as activities for older secondary and community college participants. The following pop-up activities utilized a station rotation approach. Multiple events were held both outdoors and indoors, visiting many communities located along the US/ Mexico border including the following Texas schools or libraries: Eagle Pass, Del Rio, Uvalde, Hondo, Johnson City, San Antonio, Midland, Knippa, Alpine, Marfa, and Presidio. All activities were facilitated in both Spanish and English.

Viewing the Sun



Viewing the Sun at Eagle Pass Public Library, March 2024

Primary students made their own solar viewers after listening to a read-aloud about solar viewing. Students were also invited to use the Sun spotter or view a sunspot from a telescope.

Middle School and High School students were provided a short media presentation and were challenged to design a solar viewer or use a telescope or Sun spotter.

Soundscapes

Primary students      Middle school

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were challenged to think like an ecologist and compare methods

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What is an Eclipse?	Primary students	Middle school
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used clay and a paper plate to make a replica of the Sun and Moon.

students participated in the "yardstick" eclipse activity in which a preservice

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Cardboard or Fabrication Challenge

Children were Middle School

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challenge d to build a spacecraft that could fit on a 12x12 cardboard

students were challenged to create a solar viewer, an eclipse map, or a

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Weather

Children were Microbit Weather

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encouraged to notice how the weather changes during the eclipse through a

Station was incorporated in the Summer of 2023 and upgraded somewhat to include a

### 3. Conclusion

Eclipse outreach was greatly enhanced through SRSU's La Frontera mobile makerspace programming as audiences far beyond the urban areas of San Antonio and Austin were provided frequent opportunities, rather than just on the day of or weekend prior to the eclipse. In addition to serving around 7,194 participants, the mobile van also facilitated with Eagle Pass ISD, SRSU, and SWTJC a live total eclipse viewing with scientists from NASA and the National Science Foundation's National Solar Observatory team. Over 119 adults participated in an eclipse survey at the event, with 100% of participants responding that they had never observed a total eclipse prior to the event. Preliminary analysis indicates strong increase in solar science interest, with 92% reporting an interest in learning more about the Sun and eclipses, and 70% reporting a strong interest in learning more about eclipse science. When asked about the mobile makerspace activities specifically, 62% reported the activities were exciting. In questions exploring STEM career interest, 88% of eclipse day participants overwhelmingly reported a strong interest in learning more about science-related careers as compared to math, engineering, and technology. respondents in the STEM Career Interest Survey did report increased self-efficacy among the participating preservice educators and mentors.

Educators and preservice teacher responses to the Technology Proficiency Self-Assessment for 21st Century Learning self-reported a sense of increased competency in technology integration in several areas. When analyzing Factor 3, Integrated Application Use, there were 2 additional significant findings, indicating that preservice teachers need additional support toward integrating technology across multiple platforms compared to mentors entering the program. Regarding teaching with technology, several significant findings ( $p < .05$ ) were found to support the need for preservice teachers to have additional support in integrating educational technology into planning, indicating that preservice teachers have a lower confidence level compared to mentor teachers when tasked with teaching with technology. When analyzing scholars versus mentors' use of emerging technologies from pretest data, 2 significant findings ( $p < .05$ ) indicated that scholars again need additional supports to improve their use of teaching with mobile technologies in the classroom, with a significant finding of .009, and teaching from a distance, again with a significant finding of .009. Analyzing emerging technology skills, there was a significant finding of .026, ( $p < .05$ ), supporting that preservice teachers could benefit from additional support in learning how to utilize cloud-based technologies. All significant findings highlight the need to embed stronger digital literacy instruction within the preparation program to better support preservice teachers. The eclipse participatory science programs assisted with improving stronger digital literacy skills for both seasoned educators and preservice teachers.

Repeat visits established long-lasting partnerships, with many sharing reflections from informal teaching experiences at the July 2024 Summer Science of STEM Literacy conference. The project has determined several significant findings ( $p < .05$ ), highlighting the need to embed stronger digital literacy instruction within the preparation program to better support preservice teachers in underserved isolated communities. In addition, findings suggest that stronger mentor development incorporating culturally responsive

teaching practices is needed. Posttests will be conducted in the Summer of 2025 to further explore preliminary findings with the hope of sharing final outcomes of lessons learned at the conclusion of the 2-year mentoring program.

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(n.d.-a).

(n.d.-b).

(n.d.-c).

(n.d.-d).

(n.d.-e).

(n.d.-f).

(n.d.-g).

(n.d.-h).

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