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Building a geoscience summer bridge program to Recruit Students: Impacts and Lessons Learned

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Abstract

Geoscience enrollments are declining at many institutions across the United States despite strong workforce demand. Immersive summer bridge programs are one proposed solution to this issue but are time and resource intensive. Here, we present lessons learned from summer bridge programs from our NSF GEOPAths-funded project, Geoscience Exposure and Training in Texas (GET TX). We received 177 student applications and hosted 32 high school and community college students over three summers. The program focused on water, sediment, paleontology, and geochemistry in southeast and central Texas. To showcase the diversity of geoscience, students were exposed to both field and laboratory work. Most lab and field experiences were within 30 minutes of campus; however, our capstone trip was a two-day excursion to central Texas. Laboratory experiences included: an indoor three-story rock wall; stream table; AR sandbox; groundwater models; and an ICP-AES to analyze water samples. Students observed modern processes in the first half of the program to understand and interpret the historical rock record during the last half. Among the multiple GET TX activities, these summer bridge activities emerged as the most effective strategy for positively influencing student perceptions of geoscience and encouraging enrollment in geoscience majors. As such, we present the program as a model for other geoscience programs seeking to attract students and highlight key lessons learned from its implementation.

1 Introduction

Summer bridge programs have been used to prepare students for success in STEM disciplines, as well as to recruit students to STEM fields (Bischoff et al., 2008; Carrick et al., 2016; Dahl and Droser, 2016; Houser et al., 2015). In the United States, pre-college students have little exposure to the geosciences, and often their first exposure is during an introductory level course (Stokes et al., 2015), which sometimes comes too late in a student's

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academic journey to allow for a change of major. In addition to a lack of exposure, students sometimes have negative perceptions of the geosciences or a limited understanding of the breadth of the geosciences (Moss et al., 2025; Rogers et al., 2024), and they are unaware of the career opportunities that exist and their role in benefiting society beyond traditional energy-related applications. Summer bridge programs, aimed at exposing motivated STEM-inclined students to the geosciences while still enrolled in high school and early community college, can be successful at changing student perceptions of the geosciences (Guida et al., 2025). These types of programs are one of the many approaches that shift student perceptions of the geosciences and potentially lead to increased enrollments for departments at a time when universities face budget cuts and some geoscience departments have been forced to close or drastically restructure (Geoscience on the chopping block, 2021; Yoganathan, 2026).

While these programs have been shown to be successful, they are not without challenges (Ashley et al., 2017; Jensen et al., 2021). First and foremost, field and lab-based bridge programs are often time and resource intensive in nature, as they require significant faculty time to develop, market, and coordinate. Additionally, programs open to students of all backgrounds require funding to support student housing and costs of meals, staff support, and sufficient stipends to reduce potential financial barriers. These financial and time constraints may discourage geoscience researchers from developing these impactful programs.

From 2021 to 2023, we ran a summer bridge program as part of an NSF GEOPAths grant (Award # 2022878), which supported our project called GET TX (Geoscience Exposure and Training in Texas). The bridge program was part of our broader geoscience learning ecosystem (Moss et al., 2025, Guida et al., 2025), which included open house events, high school classroom visits, and teacher workshops. In a previous study, we compared the impact of all events of GET TX and found that the bridge program was the most significant activity that changed student perceptions of the geosciences (Guida et al., 2025). Here, using previously unpublished survey data focusing on student feedback on bridge program design, we aim to provide a model for future researchers seeking to develop bridge programs.

2 Bridge Program Overview

As part of GET TX, we ran a summer bridge program from 2021 to 2023 aimed at exposing STEM inclined, pre- and early-college students to the geosciences. The primary goal of the program was to recruit students to major in geoscience, either at one of our institutions or another college/university in the U.S. Activities were led by geoscience faculty from our institutions, which are a four-year university (Sam Houston State University, SHSU), and a two-year community college (Lone Star College University Park) located near Houston, Texas, United States. We utilized resources from both campuses in laboratory, classroom, and field settings. Geology and Environmental Science majors from SHSU served as teaching and resident assistants to foster near-peer mentoring relationships that have been shown to improve outcomes for students in the sciences (Zaniewski and Reinholz, 2016). The program ran for 12 days in the first year and 10 days in Years 2 and 3. The total cost for running the program, including participant support, teaching assistant stipends, room and board, travel expenses, and faculty stipends was approximately $25,000 per summer.

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2.1 Bridge Program Recruitment, Application Process, and Participants

We sought to recruit students primarily from our region of southeast Texas, with emphasis placed on high schools within approximately 75 miles of the Houston, Texas region. Students were recruited to the program through our broader geoscience learning ecosystem (see Guida et al., 2025; Moss et al., 2025). Because students have limited exposure to the geosciences in K-12 education, we aimed to select students who demonstrated curiosity, passion for STEM-related career pathways, and strong interest in courses that are foundational to the geosciences (e.g., Chemistry, Math, Environmental Science). We set a high school or community college GPA minimum of 2.5 for applicants. In addition, room, board and an $800 stipend for bridge program completion were provided to remove potential financial barriers associated with participation.

To apply to the summer program, students filled out an application using Qualtrics online survey software, and provided one letter of recommendation from a teacher, counselor, or principal. Our applications typically opened in early January and closed in early March, with a goal of selecting and notifying applicants by early April of our decisions. In the first year, our application consisted of two short answer questions (less than 200 words): 1) Please describe why you are interested in the GET TX summer bridge program; and 2) Please tell us about your “dream” job. We allowed applicants from sophomore to seniors in high school and community college students who had completed one year of credits.

Because we ran into situations during our first year of the summer program where accepted students openly admitted to not being interested in STEM careers, despite their essays, we modified our application process to better select students with a passion for STEM disciplines and to narrow down our pool of applicants. We added three questions to the Qualtrics application: 1) Please select your top 3 choices in terms of what you think you’d like to study most in college or pursue a career in (Options: Business, Education, Engineering, Environmental Science, Geoscience/Geology, Health Care (including pre-med or nursing), Law or Criminal Justice, Math, Science (but I don’t know the field yet), Social Science (Psychology, Sociology, Political Science, etc.), Other (please list)); 2) Please briefly explain (less than 200 words) why these are your top 3 choices of what you’d like to study or pursue a career in; 3) in less than 200 words, please briefly tell us about your experience participating in groups and working with other students. Finally, we also selected a pool of applicants, 15-20 annually, for short (15 minute) Zoom interviews in which we asked three additional questions: 1) What do you expect a typical day of the program will be like?; 2) Why do you like math and science? Can you give us some examples from courses/classes you have taken; and 3) What are you hoping to get out of this program and take with you? We also gave applicants the opportunity to ask us follow up questions. While these additional Zoom interviews added time to the application process, they helped to better identify students who were curious about STEM fields and the geosciences. Finally, in Years 2 and 3, to focus on those students who had not yet decided on a college pathway, we did not accept applications from current high school seniors, as college-bound students had already decided on a college and intended major by the spring.

Over three years of the program, we had 177 applications (59 mean annually). From our pool of applicants, we selected 10, 12, and 11 students in Years 1-3 respectively. Demographic data for participants were collected from pre-surveys before participating in various aspects of our broader GET TX program (see Guida et al., 2025; Moss et

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al., 2025 for details), but given these data were collected separately from the bridge application, demographic information beyond high school or community college class year was not considered when making application selection decisions. Data are available for 24 of the 33 participants (Table 1) pre- and post-survey responses. The majority of participants were either rising high school juniors or seniors (8 each that had just finished their sophomore or junior years in the spring prior to the summer bridge), female, and white. Participant ages ranged from 15 to 22, with a mean of 16.9 years. Participants came from nine different high schools and one community college.

Table 1. Demographics of 24 of the 33 student participants as recorded in pre-survey data.

	n	%		n	%
Year in school			**Gender**		
High school sophomore	4	16.6	Female	13	54.2
High school junior	8	33.3	Male	8	33.3
High school senior	8	33.3	Non binary	2	8.3
1st year community college	1	4.2	Prefer not to answer	1	4.2
2nd year community college	1	4.2			
3rd yr community college or more	1	4.2			
1st year 4YU	1	4.2			
Race/Ethnicity					
American Indian or Alaska Native	3	13	Hispanic or Latino	9	39.1
Asian	1	4.3	Not Hispanic or Latino	15	60.9
Black or African America	2	8.7			
Native Hawaiian or Pacific Islander	0	0			
White	18	74			
More than one race	0	0			

2.2 Program Activities

We sought to emphasize place-based learning in our program, because it has been shown to have a positive impact on student outcomes, especially those from historically underserved and underrepresented groups (DeFelice et al., 2014; Kirkby, 2014; Semken et al., 2017). Because our institutions are located on the Gulf Coastal Plain of the United States, rock outcrop is limited, and most sedimentary deposits are unconsolidated. We, therefore, focused activities around water and sediment issues in the region (Table 2). The program included field experiences, hands-on opportunities, and data collection, rather than a “show-and-tell” model to better showcase to students what geoscientists do and allow them to replicate some activities and analyses that our undergraduate students do. While the majority of the program focused on areas around our campuses in the Houston metro region, the culminating capstone experience was a two-day trip to Austin, Texas where students were exposed to carbonate rocks, hydrogeology, and paleontology.

Table 2. Bridge program schedule for each year.

	Year 1	Year 2	Year 3
Day 1	Houston Museum of Natural Science	SHSU welcome and canoe trip	SHSU welcome and bowling
Day 2	Lone Star College University Park	Houston Museum of Natural Science	Houston Museum of Natural Science
Day 3	SHSU elcome and canoe trip	Lone Star College University Park	Lone Star College University Park
Day 4	Galveston Island trip	SHSU Field Station	SHSU Field Station
Day 5	SHSU Field Station	Groundwater laboratory	Groundwater laboratory
Day 6	Groundwater laboratory	Water quality analysis at TRIES	Water quality analysis at TRIES
Day 7	Huntsville water well and sewage treatment plant	Camp Cullen quarry visit/sedimentary petrography	Camp Cullen quarry visit/sedimentary petrography
Day 8	Water quality analysis at TRIES	Central TX Day 1 - Bastrop outcrop and Innerspace Cavern	Central TX Day 1 - Bastrop outcrop and Innerspace Cavern
Day 9	Camp Cullen quarry visit/sedimentary petrography	Central TX Day 2 - Mt. Bonnell, Barton Springs, and fossil collecting	Central TX Day 2 - Mt. Bonnell, Barton Springs, and fossil collecting
Day 10	Central TX Day 1 - Bastrop outcrop and Longhorn Cavern	Wrap up day - discussion, surveys, participant departure	Wrap up day - discussion, surveys, participant departure
Day 11	Central TX Day 2 - Mt. Bonnell, Barton Springs, and fossil collecting		
Day 12	Wrap up day - discussion, surveys, participant departure		

Welcome to SHSU's Campus – Our welcome day focused on orienting students with the campus and on team-building activities. Because many of our students had not been on a 4YU campus before, two project faculty and our student teaching assistants were at the dormitory during check-in to make participants feel more comfortable. In Years 1 and 2, we also ran a canoe trip on a tributary of nearby Lake Livingston to get students to start thinking about what modern fluvial settings might look like in the rock record. The trip ended at a small waterfall, which facilitated a discussion of knickpoints and the processes that form fluvial potholes. In Year 3, we opted out of the canoe trip to minimize risk, as we found some of our students were not able or were not confident swimmers and instead rented the on-campus bowling alley for students to socialize.

Houston Museum of Natural Science (HMNS) – In Year 1, our program began with a day at HMNS, a world-renowned natural history museum that houses permanent geoscience exhibits on paleontology, minerals and gems, and energy. In Years 2 and 3, this event was moved to day two. For museum visits, student participants were asked to invite along a STEM teacher from their high school that has had a significant impact on their education. To encourage attendance during the summer, teachers received a stipend ($150) for participating in the museum day. By including teachers that the students were familiar with, we hoped to ease the transition of working with college professors and foster student-teacher relationships outside of the classroom to develop more personal experiences. This can be an important factor for recruiting Hispanic geoscience students (Stokes et al., 2015). Additionally, inviting STEM high school teachers allowed us to broaden our Geoscience Learning Ecosystem and recruit for other aspects of our program. Project coordinators divided the group (10-12 students, and approximately 6 teachers), into three groups and led guided tours through the Morian Hall of Paleontology, Cullen Hall of Gems and Minerals, and the Wiess Energy Hall. Coordinators focused on how geoscientists use all STEM fields to answer a wide range of questions and the societal applications of the subdisciplines represented by each hall.

Lone Star College University Park (LSC-UP) day – The primary goal of this day was to lay foundational geoscience knowledge for students and to showcase 2YC pathways for students that can eventually transfer to a 4 YU. Assuming most had little to no background in the geosciences, we focused on hands-on, active learning

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experiences, as they have been shown to improve student learning outcomes across STEM fields (Freeman et al., 2014). LSC-UP has exceptional resources available for this, including an EMRiver stream table, a campus-wide rock garden, and an indoor three-story artificial outcrop (Fig. 1). We primarily focused on sedimentary rocks and sedimentary environments, sea level change and its signature in the rock record, hydrologic concepts, equipment geologists use in the field, and geologic and hazard maps to discuss how geoscientists interpret patterns.

Figure 1. Selected resources available for active learning on LSC-UP's campus. Left panel: three-story, 3-D, artificial outcrop. Middle panel: students taking strike and dip measurements on an oriented boulder of gypsum in the campus-wide rock garden. Right panel: EMRiver stream table to model modern river and sedimentation processes.

Galveston Island trip- This trip exposed students to an active coastal sedimentary environment and management (e.g., jetties, groynes, sand replenishment) of a dynamic geomorphic system. It also compared and contrasted engineered and developed versus natural areas (e.g., The Nature Conservancy's Texas City Prairie Preserve) to see anthropogenic and geomorphic influences on coastal conditions. Because of the driving time required (2+ hours each way), we opted out of this trip in Years 2 and 3.

SHSU's Field Station – Located on the site of a failed dam at an old state fish hatchery, SHSU's Pineywoods Environmental Research Laboratory provided an opportunity for students to observe modern stream processes and collect fossil wood (Fig. 2). Morning activities included a stream walk focusing on not only fluvial geomorphology, but also discussion on how the development in nearby Huntsville impacts the largely forested Harmon Creek basin and the influence of baseflow and low-probability flood events. This environment is also somewhat unique in the Gulf Coastal Plain, as Harmon Creek and its tributaries are downcutting through the Miocene-aged Fleming formation. In the afternoon, students used surveying equipment and velocity meters to construct stream profiles and calculate stream discharge rates. Afterwards, the faculty led a discussion about

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determining 100-year floodplains and the issues/challenges associated with drawing static maps in our dynamic world.

Figure 2. GET TX participants using survey equipment to measure a stream profile at SHSU's Pineywoods Environmental Research Laboratory.

Groundwater laboratory – Though we sought to avoid standard lecture style environments, the groundwater laboratory day started with a brief lecture that covered fundamental concepts such as the water cycle, porosity, and permeability. To reinforce these concepts and promote critical thinking, students later engaged in discussions about subsidence issues in the Houston metropolitan area. Additionally, students were given hands-on experience with groundwater models, which visualize how groundwater moves through aquifers and how surface water and groundwater interact. These models also allowed students to manipulate variables, such as increasing pumping rates or introducing contamination, and observe the corresponding changes, leading to a deeper understanding of hydrologic systems and the interconnectedness of water resources.

City of Huntsville water well and sewage treatment plant – In Year 1 of our program, we took students to visit a local water well and sewage treatment plant. Here, we sought to provide students with a real-world understanding of water sourcing and wastewater treatment processes with an emphasis on sustainable water management practices. In addition, we hoped to contextualize the importance of efficient water management in their daily lives and to link surface water being piped in from Lake Livingston (which students had canoed) and groundwater being pumped from Oligocene-aged units (which they observe at YMCA Camp Cullen, see below) to provide a city with its water supply. In addition, students heard from professional geoscientists and engineers to relate water supply and quality to applicable environmental laws and regulations.

Texas Reseaetc.nstitute for Environmental Studies (TRIES) – Throughout the program, students collected water samples (e.g., Lake Livingston, LSC-UP Campus, SHSU's field station, a lake at nearby a golf course

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community, etc.,), to analyze water quality at TRIES (Fig. 3). Students ran samples on an Inductively Coupled Plasma Atomic Emission Spectrometer (ICP-AES) to analyze for trace metals and also collected data on pH, conductivity, dissolved oxygen, alkalinity, and chloride concentration. In the afternoon, project faculty led discussions on data results and helped students compare their data to U.S. EPA and Texas Commission on Environmental Quality limits. Our hydrology and geochemistry-focused discussion also included the importance of watershed and residence time influences on water bodies. Students were able to see their own real-world results and compare/contrast groundwater versus surface water and urban and suburban drainage versus forested systems.

Figure 3. Students preparing water samples for ICP-AES analyses at *TRIES.*

YMCA Camp Cullen and microscope day – In the morning session, students observed the Oligocene Catahoula Sandstone in an abandoned quarry, which is now used for geoscience education at a nearby YMCA camp. The Catahoula is a fluvial and lacustrine volcaniclastic unit with abundant fossil plants (Ledger, 1988). At Camp Cullen, students observed a moderate-sized fluvial channel from a meandering system that is similar to the tributary some canoed earlier in the program and saw at the PERL field station. In addition, the quarry also contains a layer of volcanic ash and a large (~1 meter diameter) permineralized log that allowed for discussion of the fossilization process and its relation to Oligocene volcanic activity in west Texas. In the afternoon session, students were introduced to the optical principles of petrographic microscopes and observed hand samples and thin sections of the Catahoula sandstone from Camp Cullen. The goal here was to have students observe pore spaces at a microscopic level and better understand porosity and its importance in storing and moving fluids in geological materials, including in the aquifer that provides part of the water supply for the local region.

Central TX field trip- In all three years of the program, our capstone event was a two-day excursion to central Texas. This area provided students with an opportunity to see additional sedimentary environments and understand how the processes that had been discussed are scalable and applicable to other parts of Texas and Earth's history. The first stop on this trip included outcrops of the Calvert Bluff and Carrizo Formations near Bastrop, Texas (Fig. 4a). These formations straddle the Paleocene-Eocene boundary and provide evidence of past sea level rise and changing environments from a coal swamp to offshore marine (Yancey et al., 2013). After this stop, we took students to visit a cave in the Austin/San Antonio area. In our first year, we visited Natural Bridge Caverns in San

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Antonio, Texas. However, in Years 2 and 3 we visited Inner Space Caverns in Georgetown, TX, as it worked better logistically to reduce driving time. In addition, visiting Inner Space Caverns also allowed time for a quick stop to see dinosaur tracks in nearby Leander. At both caves, students observed karst features in limestone and discussed the importance of groundwater flow and the Edwards Aquifer in Texas. The second day of the central Texas field trip started with a visit to Mt. Bonnell on the west side of Austin, Texas, and a discussion of the importance of the Balcones fault zone in creating the Texas Hill Country and the springs that are abundant in central Texas. This site is part of the GeoSign project of the Texas Bureau of Economic Geology (BEG, 2026). After this stop, students visited nearby Barton Springs to learn about groundwater and recharge rates, watershed/recharge protection zones, and were given the opportunity to experience firsthand the cool temperatures of spring-fed groundwater. In the afternoon, students collected fossils and discussed their potential depositional environments. Stops included Cretaceous marine fossils in the Austin area (Fig. 4b) and Eocene marine fossils west of College Station, Texas.

Figure 4. A) Eocene outcrop in Bastrop, TX showing a transgressional sequence. The bottom unit is a paleosol, middle unit is a coal seam which changes thickness laterally, and top unit is a marine sand. B) Creek exposure in Austin, TX. Students are sitting on a bed of the Cretaceous oyster *Exogyra ponderosa*.

Evening programming – In each year of the bridge program, we scheduled evening activities on most nights for students to socialize or to learn more about the geosciences. Social activities were promoted using on campus resources such as SHSU's climbing wall, pool, volleyball courts, bowling alley, and a 'bad geology' movie night in one of the classrooms. We also had guest speakers talk about careers in the geosciences. One speaker highlighted careers in the oil and gas industry, whereas another highlighted careers in hydrogeology.

Code of conduct – The first iteration of our summer bridge program was run in July of 2021, the middle of the global COVID-19 pandemic and a period of significant social unrest in the United States. Events of that summer and during the first bridge program made it apparent that we needed an improved code of conduct for participants (Supplemental File S1). Our code of conduct was largely adapted from our university policies and previous summer camps run by colleagues in other departments. Each participant had to agree to and sign the code of conduct before

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participating in the program. If participants were under the age of 18, a signature of a legal guardian was also required. To stress the importance of this code of conduct, after students were checked into their dormitories, two lead faculty and our teaching assistants met with all the students as a group to discuss the importance of the agreement and expectations for working with each other over the course of the program to foster a healthy and respectful group dynamic.

3 Methods

To assess the effectiveness of and make improvements to our program, we implemented three survey instruments. The first, which was distributed to students as a paper copy on the last day of the program, consisted of six questions that sought to understand student interest and self-efficacy in geoscience and their intent to pursue geoscience in college. Questions for interest and self-efficacy included: Q1) How confident are you in doing geoscience? Q2) How interested are you in doing geoscience? Q3) How useful is geoscience? Questions for intent to pursue geoscience included: Q4) What is the likelihood that you will take a geoscience course in the future? Q5) How likely are you to consider studying geoscience for your Bachelor's degree? Q6) What is the likelihood you will consider Sam Houston State University or Lone Star College-University Park for a geoscience education? Respondents were given the choice of "Not at all", "Somewhat", "Very", for each of the previous questions in addition to a free response opportunity to "briefly explain" their choice (Supplemental File S2).

The second survey, also distributed on the last day of the program as a paper copy, was a more informal, internal survey to understand student likes and dislikes about the program. This survey consisted of 10 free response questions and two quantitative questions (Supplemental File S3). To understand student preference and interests for each day of the program, we asked students to circle from a list of options the three days they liked the most and, in another question, the three days that they liked the least. We also asked students to explain what they liked/disliked about each of these days. Free responses were typed into Excel to organize data and search for common themes in responses.

Our final survey was an online follow-up Qualtrics survey conducted in 2024. This survey was conducted after all bridge programs were completed and after all but one student participant was enrolled in college. In this short survey, we asked participants which college or university they ended up attending and what their major was in order to determine the overall program impact.

4 Results

4.1 Student interest, self-efficacy, and intent to pursue Geoscience post summer bridge program

Surveys completed at the end of each bridge program showed a positive impact on student self-efficacy and perceptions of the geosciences from the experience (Figure 5, S4). Confidence in doing geoscience (Q1) was lower in Years 1 and 3, with the majority of students (7 of 9, and 7 of 11) indicating that they were "somewhat" confident in doing geosciences versus all 12 students indicating they were "very" confident in Year 2. Students also indicated a "very" high level of interest in geoscience (Q2) and unanimously agreed that the geosciences are "very" useful (Q3) in all three years of the program. For questions related to intent to pursue geoscience in the future, students had more

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varied, though still mostly positive, responses. Responses for Year 1 saw the most variation of any year, including the only "Not at all" responses for any of the questions we asked. In addition, Year 1 saw fewer "Very" responses and more "Somewhat" responses. However, in Years 2 and 3, the number of "Somewhat" responses decreased, while the number of "Very" responses increased for Q4, Q5, and Q6.

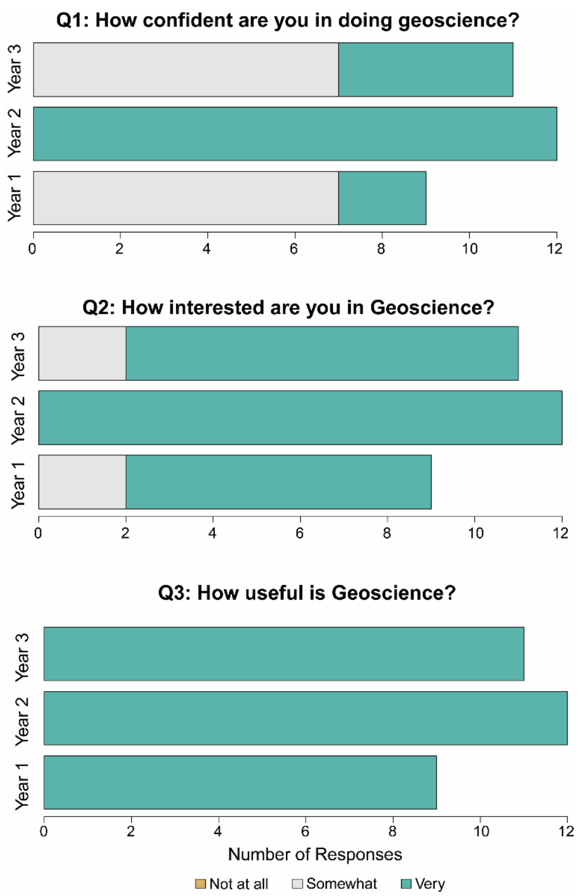

Figure 5. Student responses to questions focused on self-efficacy and geoscience interest after participating in bridge program.

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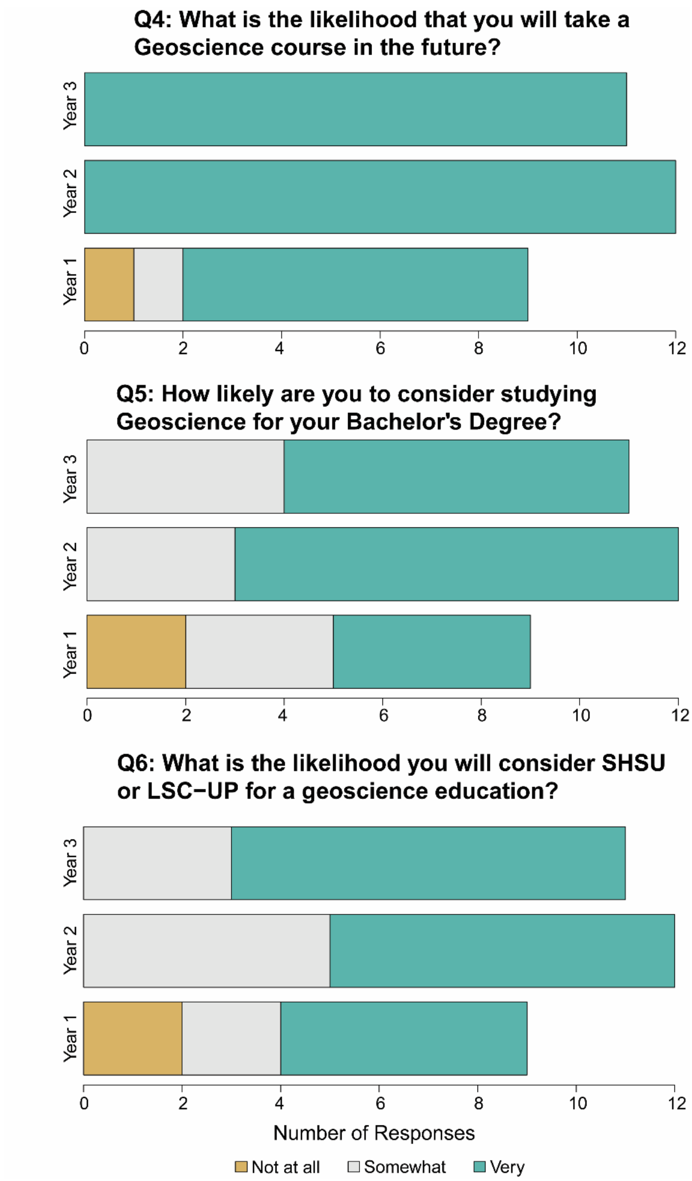

Figure 6. Student responses to questions related to intent to pursue geoscience after completion of the summer bridge program.

4.2 Student feedback on program content

Student preference for program days consistently ranked the Houston Museum of Natural Science, field station fluvial geomorphology and hydrology measurements, and central Texas field trip days as the most liked of the program (Figure 7, S5). Although many of our students were from the Houston area, most had not visited the

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museum before participation in GET TX. The capstone field trip to central Texas was also a highly popular day between all three cohorts.

In Year 1 and Year 2, the TRIES water quality analysis day received only a few votes, whereas during 2023, it was one of the most popular days. In Years 2 and 3, we dropped the sewage treatment plant because students in Year 1 overwhelmingly indicated that this was their least favorite activity. Finally, as stated before, to improve program logistics, we decided not to run the Galveston Island field trip after Year 1.

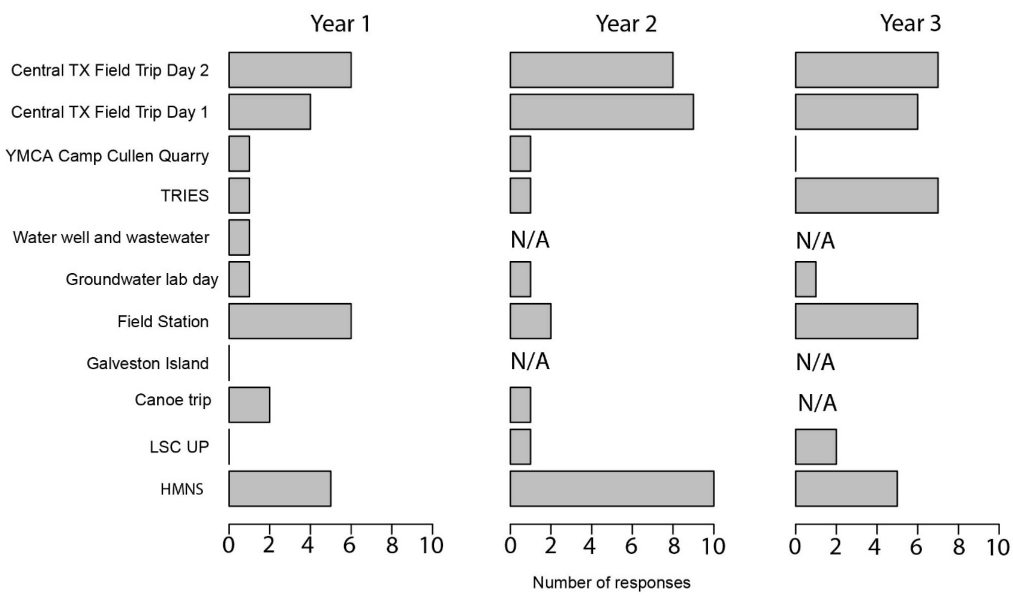

Figure 7. Student response by year to which days they liked most of the program. Students were asked to pick their three favorite days but were not asked to rank them in order of preference.

Student comments for preferences for these days centered around three main themes: Active/Hands-on learning (16 responses), Outdoor experiences (9), and guided tours of the museum (6). One student comment selected below illustrates these themes nicely:

> *"These days explored multiple subjects in one sitting, allowing for higher understanding and exploration. The Museum allowed for an introduction to the multiple types of geoscience through group exploration. The two Central Texas days were also highly rich in exploration as students made their own observations from the knowledge gained on previous days. The Central Texas days had multiple activities linked in ways through the location's geology. The constant movement and discussion within these days made them go by much faster and enjoyably. I wouldn't mind repeating them."*

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Another student responded similarly, with the addition of the museum providing wide coverage of the geosciences:

> *"That they gave us a chance to walk around and explore our surroundings and then have a brief talk and explanation of certain parts. I enjoyed walking around for all of these… instead of stand[ing]-still. For me specifically the museum gave me a chance to understand a lot of little parts of geoscience and I enjoy change."*

Our activities were aimed at providing hands-on learning experiences, rather than only show and tell, as we thought this would better engage students, and the open-ended responses indicate that this was successful. In addition, while dealing with summertime temperatures in southeast Texas requires preparation and care, GET TX students appreciated being outdoors and getting to observe and interpret geologic features. In addition, six of the responses mentioned not only seeing, but also finding fossils as a highlight of these days.

When we asked students, "What is one thing from the program that will stick with you?", we saw similarly themed responses. Students frequently commented on the bond/relationships they made with their peers (6 responses) and the faculty that lead the program (5 responses):

> *"The bond that was made as we all learned together in a healthy learning environment with amazing teachers."*

> *"The Drs! They make me want to come to school here. They are just so amazing! They know how to handle thing[s] and how to make this a great learning environment!"*

Students also commented frequently (9 responses) on how the program helped them to see the relevance and importance of not only geosciences as a field, the related career opportunities, as well as how the nature and design of the program allowed them to gain new experiences and appreciation for the outdoors and to seek knowledge in different ways than before:

> *"The outdoors are so much more fun than it was previously thought and makes me want to explore more."*

> *"We were making observations at the YMCA quarry, and even though I had noticed enough of the physical features to make an interpretation, I found it difficult to think of explanations and possibilities. I realized I need to question and wonder about things more rather than just wait for explanations."*

4.3 Effectiveness of the program

Survey data collected one year after the conclusion of the third and final year of the summer bridge program suggests that the program had an impact on student decisions to choose geoscience as a major in college (Table 3). Of the 33 students, 24 (72%) responded to the follow-up survey sent in 2024, all of whom reported attending a four-year university. Of these 24 students, nine chose Geology as a major, whereas five chose geology-adjacent pathways

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that were discussed at times during GET TX (e.g., Environmental Science or Geographic Information Systems (GIS)). In addition, nine students ultimately enrolled at one of our institutions (SHSU).

Table 3. Follow up survey results to track participant college major. 24 of 33 participants responded. Bold indicates either SHSU enrollment and/or geology or geology adjacent major.

Cohort	Which college or university did you attend or are you currently attending?	If you attended a college or university, what is/was your major?
Year 1	Baylor University	Journalism Public relations
	Sam Houston State University	**Geographic Information Science**
	Sam Houston State University	**Geology**
	Sam Houston State University	Construction Management
	Texas A&M University	**Geographic Information Science**
	The University of Texas at Austin	**Geology**
	Wellesley College	Chemistry and English
Year 2	Colorado School of Mines	Electrical Engineering
	Illinois Institute of Technology	Chemistry
	Sam Houston State University	**Geology**
	Sam Houston State University	**Geology**
	Sam Houston State University	**Geology**
	Texas A&M University at Galveston	Marine Biology
	Texas A&M University	**Geology**
	Texas A&M University	Biomedical Sciences
Year 3	Brigham Young University	Anthropology
	*still applying	*Environmental Policy
	Sam Houston State University	**Geology**
	Lone Star College	Computer Science
	Sam Houston State University	**Geology**
	Sam Houston State University	**Environmental Science**
	The University of Texas at Austin	**Geosystem Engineering & Hydrogeology**
	University of Texas at Austin	**Environmental Engineering**
	UT Arlington	**Geology**

5 Discussion

As we and others have discussed elsewhere (Carrick et al., 2016; Dahl and Droser, 2016; Guida et al., 2025), summer bridge programs can be impactful in recruiting students to the geosciences. A total of 33 students participated in our program over three years. Of the 24 that took the follow-up survey, 14 (58%) attended a four-year university to pursue a geoscience major. In comparison, over ten years with larger participant numbers, a similar program at the University of Texas at El Paso only saw a 20% rate of students enrolling in geoscience majors (Carrick et al., 2016). Rather than waiting for students to enroll in introductory geoscience courses, successful bridge programs targeted at pre-college STEM-inclined students offer an early avenue to build relationships and

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recruit students. These programs are not easy to run, nor is there a one-size-fits-all approach given the varying resources, locations, and funding available to geoscience programs. Though the data we presented here suggest that our program was successful in recruiting students not only to our geology program but to others, it also implies room for improvement in future iterations. Below we discuss some of the most important lessons learned from our experiences and from survey data in hopes of providing a model for future researchers looking to create a summer bridge program.

Lesson 1: Partnerships with local institutions are invaluable. Lesson 1: Partnerships with local institutions are invaluable. Local natural history museums or collections can help to highlight the wide range of questions that geoscientists not only answer but also ask. We were fortunate to be within driving distance of the Houston Museum of Natural Science, which features several extensive exhibit halls. These exhibits allowed for a more detailed discussion of the societal relevance and importance of geoscience in an engaging and captivating format. Clearly articulating the societal relevance of geoscience has been shown to be an impactful recruitment tool (Carter et al., 2021; Moss et al., 2025). The Morian Hall of Paleontology, in addition to displaying numerous *Tyrannosaur rex* skeletons and other fascinating beasts, also illustrated mass extinctions through time. Our faculty were able to tie this into the current diversity crises and the likely sixth mass extinction already underway (e.g., Cowie et al., 2022) and highlight the importance of understanding diversity and changes in the Earth through interpretation of the rock record. Specimens displayed in the Cullen Hall of Gems and Minerals provided visual experiences for participants as our faculty described economic uses of minerals and discussed potential career pathways. We explained to participants that some minerals are mined for the elements they contain (iron, copper, lithium for example), while others are extracted because of their physical and/or chemical properties. For example, garnet may be used as a gemstone or as an abrasive in sandpaper and emery boards/nail files. Gypsum is used to make plaster and drywall/plasterboard. Emphasis was also placed on minerals (e.g., spodumene, lepidolite) that are sources of lithium and rare earth elements that are vital to modern technology. Finally, in the Weiss Energy Hall, students learned about the importance of the petroleum industry to our region. These exhibits illustrate how geoscientists not only explore for but also extract oil and natural gas from the ground. In addition to fossil fuel energy, exhibits also discussed modern energy needs and how geoscientists are exploring other resources that power the world. They also gained an appreciation for all of the products that use petroleum.

At the outset of our program, we incorrectly assumed that many students would have previously visited the HMNS given most of them were from the Houston metro area. However, we quickly learned that this was not the case and survey data indicated that the HMNS visit was one of the most liked days of the program (Figure 7) and allowed students to see a glimpse of the breadth of the geosciences. Similarly, the partnership with YMCA Camp Cullen in Trinity, Texas allowed participants to observe and interpret ancient fluvial deposits. In our location on the Gulf Coastal Plain, outcrop is rare, and access is typically limited to quarries or stream gullies, many of which are on private land. We encourage anyone interested in developing summer programs to explore potential partnerships with area educational institutions of any scale as they likely have additional resources which could expose students to new and engaging material beyond that available at their home institutions.

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Lesson 2: Keep things active and remember the goal is to recruit students, not to train them. Survey responses indicated that students most enjoyed the days where they were active participants, rather than passive listeners. This is not really a surprise given recent studies promoting the benefits of active learning in STEM fields (Holley, 2017; Huguet et al., 2020). At the outset of our program, we may have overloaded the students with too much information. While we were concerned that students came to us with little geoscience exposure, as is common in K-12 in the United States (Betzner and Marek, 2014; Gonzales and Keane, 2010; Sherman-Morris et al., 2019), student engagement increased when we pulled back on the more nuanced details of what we were trying to convey. In other words, the "keep it simple" approach works well with pre-college students. Ideally, summer programs should introduce students to the basic principles and ways of thinking in geology and the types of questions we aim to answer, while providing some hands-on opportunities. Although, we acknowledge that students who have more well-defined ideas of fields they plan to pursue can also benefit from immersive research experiences.

Lesson 3: Seek a balance between indoor and outdoor activities. Geology as a discipline and geology careers are often viewed as being "field intensive," whereby geologists spend most of their time outdoors (Rogers et al., 2024). While this can be a motivating factor for some students when deciding on college majors (Miranda et al., 2021), it can also be a discouraging factor or even a barrier to some (Carrera et al., 2024; Carter et al., 2021; Giles et al., 2020). In our region of the United States, high summertime temperatures, coupled with high humidity, make outdoor education tricky and increase safety risk. While many students reported enjoying the field experiences (Figure 7 and supplemental file), many also reported negative associations with extreme heat. Researchers designing summer programs should consider ways to help prepare students for being outdoors for long periods of time if that is a significant component of their program design. For example, we provided a detailed breakdown of each day of our program with guidance for what type of clothing would be most well-suited for each experience (i.e., a packing list) a few weeks ahead of the program. For many students, hiking through a stream at our on-campus field station was a novel experience met with not only exposure to heat but wildlife (e.g., venomous snakes). Before heading out on our hike, we also gave students an idea of what they might experience in our pre-hike safety discussion. While learning in the field is a foundational component of many geoscience programs at universities (Mogk and Goodwin, 2012), bridge programs should not lose sight of the fact that most professional geoscientists spend the majority of their time indoors and work in a wide range of laboratory and office settings. To recruit more students to major in the geosciences, we should not only discuss but demonstrate the wide range of career pathways available to them based on reported interest of the next generation of college students (Moss et al., 2025). Designing a program which incorporates a balance of both indoor and outdoor activities can help to ensure that this goal is met.

Lesson 4: *Shorter programs might be just as effective.* Our program ran for 12 days the first year and 10 days in Years 1 and 2. However, other studies have demonstrated that shorter programs are also effective at recruiting students and could help lower overall program costs (e.g., Dahl and Droser, 2016). Furthermore, according to our survey data, there were some days that students did not have as high a level of interest in, so geoscientists should

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consider designing program days around topics that promote active learning (Drennan and Evans, 2011) and or kinesthetic learning (e.g., Goldsmith, 2018). In terms of bridge program curricula and duration, programs could be shorter or longer, as long as they cover issues and topics that students can connect to modern society like we have demonstrated here. As Ferrier et al. (2026) point out, "there is no universal geoscience curriculum." Program designers should also carefully consider their start and end days of the week. Our program typically started on a Sunday and ended in the middle of the week to accommodate all aspects of the itinerary. If we were to run this program again, we would likely a Sunday-Sunday, selecting carefully from the days students consistently ranked high on our surveys. This schedule would also better facilitate parent drop-off of participants, which is important in building connections with families in order to recruit students from underrepresented and first-generation groups (e.g., Carrera et al., 2024; Stokes et al., 2015).

Lesson 5: Developing relationships with area high school students is a powerful recruiting tool. As we have discussed elsewhere, recruitment of students to the geosciences faces myriad issues (Moss et al., 2025), notwithstanding a lack of exposure. Summer bridge programs like ours help to not only introduce pre-college students to the field, but they also allow for professors to build connections with students and their families that can have a significant impact on college choices. This might be particularly true for regional institutions like ours (SHSU), which often compete for the interest of top high school students with much larger, more well-known, and better funded programs. At least anecdotally, most of the participants that ultimately enrolled at SHSU had offers to attend large R1 universities in the area but chose us based on their experiences during the program. Before starting the GET TX program our department (Environmental and Geosciences) had 44 students majoring in Geology. After the last year, this number increased to 65, some of which we attribute to the marketing efforts and relationships built through our larger geoscience learning ecosystem (Guida et al., 2025). During the three years of the program, we consistently recruited three students from each cohort to enroll at our university (Table 3), with seven of these (21% of all participants) majoring in geology. Of these seven, five have already finished degrees with us, one will finish this fall, and one more has recently started. All these students have made tremendous impacts on our department; many were not just active in, but leaders of student organizations and several participated in research with faculty, which led them to fully funded opportunities in graduate school geoscience programs across the country.

Conclusion

Summer bridge programs can be time- and resource intensive, but if done with care, they can pay off for geoscience departments hoping to increase their enrollments. Such programs can be tailored to fit resources available at a range of institutions. Our program ran for 10-12 days over the course of three summers and was successful at recruiting students to major in geoscience. Some of these students enrolled in our department and have consistently been amongst our top students over the past several years. Researchers and teaching faculty looking to develop such programs should aim to 1) form partnerships with local educational institutions to expand available resources; 2) focus on active learning strategies in their program design; 3) find a balance between indoor and outdoor activities; and 4) find a program length that logistically fits their goals and resources. With careful design and implementation,

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bridge programs can be successful at building relationships with pre-college students and providing them with an invaluable pathway into a geoscience program.

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Ethical Statement

The research conducted here was approved by the Institutional Review Board at SHSU (Approval #2020-152).

Data Availability

All data are made available as part of the supplemental files. Data have been anonymized as part of our IRB approval.

Author Contribution

All authors contributed to aspects of the summer bridge program. Moss led development of the manuscript, figures, and data analysis. All authors contributed feedback and edits to the manuscript before submission.

Competing Interests

The authors declare no competing interests.

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