Chapter 10

STEM Enrichment Through FSM: A Graduate-Led Summer Camp Model for Equitable Learning in Math and Science

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Chapter Highlights

The following highlights summarise the design, implementation, and impact of the Foundations in Science and Mathematics (FSM) program as a sustainable and equity-focused STEM outreach model, highlighting its role in broadening access to STEM learning and supporting graduate instructor development.

- Program Origins and Purpose – Introduces FSM as a graduate-student-led outreach program launched in 2010 at Indiana University, aimed at broadening access to STEM education for middle and high school students.
- Curriculum and Pedagogical Approach – Highlights student-centred, practice-oriented enrichment courses across mathematics, science, robotics, and coding, connecting academic rigor with real-world relevance.
- Program Organization and Partnerships – Examines key organisational elements, including instructor recruitment, curriculum planning, and collaboration with local schools and families.
- Equity and Accessibility Measures – Describes strategies such as hybrid delivery formats, financial support, and cross-departmental collaboration to ensure inclusive participation.

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Introduction

STEM education has increasingly been recognized as central to preparing students for the demands of the 21st century workforce and society. Beyond traditional classroom instruction, out-of-school learning opportunities such as summer camps have become popular vehicles to foster students' interest, motivation, and achievement in science, technology, engineering, and mathematics (STEM). Researchers have examined these informal learning environments for decades, highlighting their potential to counteract summer learning loss and promote long-term engagement with STEM disciplines. A foundational concern addressed by summer programs is the phenomenon of summer learning loss, in which students' academic achievement declines during extended school breaks. Cooper et al. (1996) provided one of the most comprehensive early reviews, demonstrating through a meta-analysis that students typically lose achievement in mathematics and reading during summer vacation, with losses disproportionately affecting students from lower socioeconomic backgrounds. This finding has since been widely cited to justify the design and implementation of summer enrichment programs, including those focused on STEM, as a means of mitigating educational inequalities (Alexander et al., 2007).

Building on this foundation, scholars have emphasized the role of STEM camps in sustaining or even enhancing students' academic trajectories during the summer. For example, Young et al., (2017), in their meta-analysis, found that out-of-school STEM experiences significantly increased students' interest and attitudes toward STEM fields, providing evidence that structured programs beyond the school day can shape career aspirations and motivation. Similarly, Drey (2016) documented the positive influence of STEM summer camps on students' motivation and interest in mathematics and science, underscoring the motivational power of hands-on and inquiry-based activities.

Recent research continues to explore the ways in which STEM summer programs can develop both content knowledge and affective outcomes. Tekbıyık et al. (2022) investigated a robotics-focused summer camp and found that students not only developed more sophisticated knowledge structures but also reported stronger STEM career interests, suggesting the importance of thematic and technology-rich camp models. Franks and McGlamery (2021) extended this conversation to preservice teachers, showing that teaching in a summer STEM camp enhanced mathematics teaching self-efficacy among future educators. This dual impact on both students and instructors illustrates the broader educational value of summer

STEM initiatives. In addition, other studies have explored organizational and pedagogical aspects of STEM camps. Davis and Hardin (2013), for instance, provided practical guidelines for structuring STEM camps that are both engaging and inclusive, especially for students with exceptional needs. Their work emphasizes that the design of these camps is as critical as their content, requiring attention to accessibility, differentiation, and sustainability. These perspectives resonate with more recent calls to align STEM camps with authentic scientific and engineering practices, ensuring that students experience STEM in ways that mirror professional inquiry (National Research Council, 2012).

Together, these strands of research demonstrate that STEM summer programs are not isolated interventions but rather part of a growing body of educational practice and scholarship. Meta-analyses (Cooper et al., 1996; Young et al., 2017), empirical studies (Drey, 2016; Tekbıyık et al., 2022), practitioner-oriented guides (Davis & Hardin, 2013), and studies of teacher development (Franks & McGlamery, 2021) all affirm the importance of summer STEM camps as both a response to learning loss and a catalyst for long-term engagement in STEM. By situating our work within this literature, we highlight FSM's summer camp model as both part of this broader tradition and a unique case of STEM enrichment situated within a university-community partnership.

Origins and Purpose of FSM

The Foundations in Science and Mathematics (FSM) program began with a straightforward question: How can graduate students in STEM and STEM education meaningfully serve their local community? In 2010, a small group of Indiana University graduate students took this question to heart and created a summer program designed to provide high-quality, affordable STEM learning opportunities for middle and high school students in the Bloomington area. Since its inception, the program's mission has remained clear to build an accessible, inclusive, and intellectually stimulating summer environment for young people eager to explore science and mathematics.

From the outset, FSM was grounded in values of access, equity, and collaboration. The program was never intended simply to "fill gaps" in academic preparation; rather, it sought to invite students into a space where STEM could be experienced as engaging, relevant, and empowering. The emphasis extended beyond improving test scores to helping students develop confidence as learners and problem solvers, while also providing them with instructors who were close in age but deeply knowledgeable and enthusiastic about their fields.

What makes FSM distinctive is its graduate-student-led structure. Unlike many outreach efforts initiated and overseen primarily by faculty or institutional administrators, FSM has been carried forward by the energy and commitment of graduate students and advanced undergraduates. These individuals have guided the program's planning, teaching, and day-to-day operations. This bottom-up approach has allowed FSM to remain flexible and responsive, with its courses, teaching strategies, and outreach activities evolving directly from the insights and experiences of those actively engaged in the work.

Over time, the program has grown in both scope and impact. Course offerings have expanded, partnerships with different university units have strengthened, and FSM has reached a wider pool of students across the region. As the program has matured, so too has its purpose. Beyond enriching the learning of participating students, FSM has become an important site for the professional development of instructors. Graduate students gain first-hand experience in curriculum design, classroom teaching, and educational leadership, preparing them for future careers in education and academia. In this way, FSM contributes not only to the development of the next generation of STEM learners but also to the preparation of the next generation of STEM educators.

Program Design and Operations

Instructor Recruitment and Preparation

A central hallmark of the Foundations in Science and Mathematics (FSM) program is its graduate-student-led teaching model, which has guided both the recruitment process and the preparation of instructors since the program's inception. Unlike many outreach initiatives that rely primarily on faculty leadership, FSM intentionally places graduate students and advanced undergraduates at the forefront, providing them with the opportunity to design and teach enrichment courses in their fields of expertise. This design accomplishes two goals simultaneously: students in the program are taught by instructors with advanced content knowledge, while graduate students gain valuable hands-on teaching experience that contributes to their professional development.

The recruitment cycle typically begins in early fall. An interest survey is shared widely across STEM departments at Indiana University, inviting potential instructors to indicate both their willingness to teach and the subjects in which they feel qualified. To spark ideas, the FSM website highlights commonly offered courses such as Algebra I, Chemistry, and Python Programming. At the same time, instructors are encouraged to propose new course ideas. When a novel proposal is made, faculty mentors often step in to provide constructive input on course design to ensure feasibility and alignment with the program's goals.

Toward the end of the fall semester, FSM hosts a call-out meeting for interested candidates. This meeting functions as an orientation and a matchmaking step, helping align instructors with courses that suit their academic background. For example, mathematics courses are typically assigned to graduate students in mathematics or mathematics education, while courses in biology, chemistry, or computer science are paired with students from those respective disciplines. If multiple candidates request the same course, priority is given to those with departmental ties, prior teaching experience, or a strong record of engagement in STEM outreach. Returning instructors who have previously taught with FSM are also prioritized; this practice not only strengthens continuity and program stability but also honors the contributions of individuals who have already invested in the program's mission.

Once instructors are selected, FSM implements a structured preparation process during the spring semester. Instructors are grouped by subject areas mathematics, sciences, or computer science and each group is supported by a course administrator. These administrators serve as coordinators, helping to facilitate lesson planning, organize shared resources, and provide logistical guidance. They also play a crucial role in onboarding new instructors by sharing existing instructional materials such as past syllabi, worksheets, manipulatives, and project-based activities. Instructors can adapt these resources or develop entirely new curricula, but all finalized materials are expected to be uploaded to a shared drive to benefit future cohorts of instructors.

Throughout the spring, monthly meetings are held to build community among instructors and provide training. These sessions cover logistical topics (such as scheduling and classroom assignments), pedagogical expectations, IRB and research protocols, classroom management strategies, and available teaching resources. Faculty advisors are accessible to provide additional support, particularly for instructors piloting new courses. Importantly, FSM recognizes that most instructors balance teaching preparation with research and coursework, so the program intentionally cultivates a collaborative, flexible, and supportive environment.

During the summer sessions, instructors receive both logistical and instructional support. Program staff monitor attendance records, maintain a shared spreadsheet that tracks student progress through pre- and post-tests, and act as a point of communication with families. Parents and guardians are encouraged to reach out to the FSM email account with concerns or questions, and relevant feedback is shared with instructors. At the close of each course, anonymous student surveys are collected, providing insights into both teaching effectiveness and student experiences. This ongoing feedback loop strengthens the program's ability to improve from year to year.

The teaching load is designed with sustainability in mind. Most instructors teach one course per session, though some may teach in both of the two summer sessions if needed. In cases where enrollment is small, a second instructor may be assigned to meet supervision requirements and provide classroom support. Additional instructors are occasionally kept on reserve to address illness, scheduling conflicts, or unexpected changes.

Ultimately, FSM's instructor model is grounded in a balance of trust and structured support. Instructors are trusted to design meaningful and engaging learning experiences for their students, while the program ensures that they are equipped with resources, mentorship, and a collaborative peer network. This reciprocal structure has been key to maintaining both the quality of instruction and the enthusiasm of instructors across successive years.

Course Offerings and Curriculum

Each summer, FSM provides a diverse and evolving catalog of STEM enrichment courses. The offerings range from core subjects such as algebra, biology, and chemistry to more specialized options including computer programming, psychology, and SAT preparation. Courses reflect both student interest and instructor expertise, leaving room for creativity and flexibility. While staple courses like Algebra 1 and Python Programming are offered almost every year, others arise from instructor initiative, such as robotics or interdisciplinary courses that connect mathematics with art.

The program is structured into two sessions, usually held in June and July. Courses meet three days a week, Mondays, Wednesdays, and Fridays, for two hours per day over a two-week period, creating a total of 12 hours of instruction. To support pacing, instructors are encouraged to divide each day into two 50-minute blocks separated by a short break, followed by time for questions and reflection. This rhythm helps sustain student focus while balancing direct instruction, collaborative activities, and exploratory work.

Class sizes are intentionally kept small, with enrollment capped at ten students and a minimum of two. Most classes fall between three and six students, which allows instructors to adapt lessons and engage students in interactive ways. If a course enrolls only one student, program policy requires assigning a second instructor to ensure quality. The result is an environment that feels closer to tutoring than to a traditional classroom.

Clear expectations and learning goals are emphasized from the start. Instructors may format these in different ways, but every course begins with a short pre-test and ends with a post-test to measure student growth. Many instructors also integrate projects, group activities, or reflective tasks, particularly in courses like programming, psychology, or the sciences. Courses in biology, chemistry, or environmental science often include laboratory components. The university provides lab space, safety equipment such as goggles and coats, and requires families to sign a safety consent form. Instructors receive logistical and financial support in securing materials, ensuring that lab-based classes are both rigorous and safe.

Technology plays a central role across the curriculum. Classrooms are equipped with projectors and computers, and instructors often use digital platforms like Desmos, GeoGebra, or Python IDEs. These tools enrich lessons whether students are graphing functions, simulating chemical processes, or designing code. The program's technical and material infrastructure is designed to make experimentation and exploration accessible in every subject. Developing a new course typically begins months in advance. Once course descriptions are finalized and advertising begins, instructors work with coordinators and faculty mentors to refine lesson plans, prepare materials, and document their approaches for future use. Whether revising an established course or piloting a new idea, instructors are expected to upload all teaching materials to a shared drive so future teachers can build on their work.

This combination of flexibility, structure, and institutional support allows FSM to offer a wide range of STEM learning experiences while maintaining a consistently high standard of instruction. To illustrate how these offerings come together in practice, Table 1 presents a sample schedule of the 2025 summer courses across both sessions. The courses span mathematics, science, and interdisciplinary topics, with options delivered in both in-person and hybrid formats, reflecting FSM's commitment to accessibility and variety.

Table 1. Sample course schedule from FSM 2025 summer program (both sessions).

Session 1: June 2-June 13, 2025, Monday- Wednesday - Friday			
Time	Course 1	Course 2	Course 3
9:00-11:00	Algebra 2**	Intro Biology*	Intro Physics*
11:30-1:30	Algebra 1*	Pre-Calculus*	Intro Programming*
1:45-3:45	Standardized Test Review**	Psychology and why it matters*	Intro Chemistry*
4:00-6:00	Geometry*	Coding in Python**	Advanced Chemistry*
Session 2: July 7-July 18, 2025, Monday- Wednesday - Friday			
Time	Course 1	Course 2	Course 3
9:00-11:00	Algebra 2**	Viruses and our world*	Brain Science*
11:30-1:30	Algebra 1*	Pre-Calculus*	Intro Chemistry*
1:45-3:45	Standardized Test Review**	Intro Physics*	Coding in Python**
4:00-6:00	Geometry*	Zoology*	Intro to Astronomy*

*Only in person, **Hybrid (online or in person)

Student Recruitment and Enrollment

Recruitment of students for the Foundations in Science and Mathematics (FSM) program begins each spring and is intentionally designed to reach a wide spectrum of learners. Because the program is hosted at Indiana University, many participants come from Bloomington and surrounding counties, yet the program also attracts students from across Indiana and occasionally from neighboring states. The recruitment effort therefore aims to balance two goals: ensuring that local students and families are aware of the opportunities available, and opening the program to a wider audience who may benefit from summer enrichment experiences in STEM.

The outreach strategy has gradually expanded to include multiple channels. Traditionally, recruitment has relied on personal networks and word of mouth, especially through parents of past participants who often share positive experiences with peers. To strengthen these informal efforts, the FSM team also coordinates with local schools, community organizations, and youth programs. Information flyers and digital announcements are distributed through school mailing lists, while teachers and counselors are encouraged to nominate students who may thrive in enrichment settings. In recent years, social media platforms and targeted email campaigns have become increasingly important in widening the program's visibility. These efforts ensure that recruitment is not limited to families already familiar with Indiana University, but instead reaches a diverse pool of potential participants.

Enrollment officially opens each year on March 1 through an online registration system hosted by the university. Families can review the available course offerings, session dates, and times before selecting the courses that best align with their child's interests and schedules. Because courses often fill quickly, early registration is encouraged. The administrative team tracks enrollment numbers carefully and maintains waitlists for high-demand courses, notifying families if additional seats become available. The enrollment system also collects demographic data, prior coursework, and areas of interest, which helps instructors tailor their courses to the needs and backgrounds of incoming students.

Equity and accessibility remain central concerns throughout this process. The program strives to keep tuition costs affordable while also providing fee waivers or reduced rates for families with demonstrated financial need. In addition, courses are scheduled with flexibility in mind, offering both morning and afternoon sessions so that families can select times that do not conflict with other summer commitments. Together, these efforts underscore FSM's dual mission: to expand access to high-quality STEM learning opportunities and to maintain a supportive, inclusive community of learners each summer.

Scheduling and Facilities

Over time, FSM has established a summer schedule that is both predictable and flexible, making planning smoother for instructors, students, and families. Each year, the program runs in two sessions: the first begins on the first Monday in June, and the second starts on the second Monday in July. This structure has remained steady for more than a decade, and its consistency has been key for returning families, who are able to plan their summers in advance, and for instructors, who can reliably anticipate when their teaching responsibilities will occur.

Each session spans two weeks, with courses meeting three times per week on Mondays, Wednesdays, and Fridays for two hours per day. This format balances intensity and manageability: students complete a full 12 hours of instruction in two weeks, while instructors have non-teaching days in between to revise materials, prepare new lessons, and follow up with students. The rhythm of the schedule has become one of FSM's strongest features, accommodating a variety of summer calendars while maintaining a meaningful depth of learning.

Classes are held in multiple buildings on the Indiana University campus, including Ballantine Hall, the Chemistry Building, and the Biology Building. These facilities were chosen for their proximity to one another, which simplifies navigation for families, and for the specialized resources they offer. Laboratory courses such as biology and chemistry are scheduled in university labs that meet safety requirements, while programming and SAT preparation courses take place in classrooms with projectors, computers, and reliable internet access. The program coordinator, a graduate student, typically manages the process of reserving rooms, though faculty advisors and departmental staff assist with navigating IU's scheduling system and coordinating with science departments. Over time, FSM has developed strong relationships with these units, ensuring that classroom and lab space is consistently available each summer.

On the first day of each session, a registration desk is set up in the main building to welcome families, guide students to classrooms, and collect any final documentation. This desk is staffed by coordinators and instructors from morning until evening and serves as the central hub for communication. It may seem like a small detail, but this welcoming point has been crucial in setting the approachable and supportive tone that families have come to associate with FSM.

Because FSM is also a research initiative, instructors are required to complete certain compliance trainings. All instructors are added to the program's IRB protocol, since pre- and post-test data, along with student surveys, are used for evaluation and research purposes. Those who have not already completed CITI (Collaborative Institutional Training Initiative) training must do so before the summer begins. For laboratory-based courses, instructors must also complete safety training if they have not already done so through their home departments. FSM provides all the necessary lab materials and protective gear such as goggles, gloves, and lab coats and strictly follows IU's established safety procedures. These layers of preparation ensure that classes are not only engaging, but also safe and research compliant.

Importantly, FSM has not struggled to secure facilities. The scale of Indiana University's campus, combined with the relative flexibility of summer scheduling, has made it possible to find appropriate spaces even as the number of courses has grown. Proactive planning by the leadership team, coupled with strong departmental partnerships, has kept operations smooth and reliable year after year.

To highlight how this planning unfolds across the academic year, Figure 1 presents the FSM Program Timeline, a month-by-month overview of major milestones such as instructor recruitment, course scheduling, student enrollment, and the summer sessions themselves. The timeline illustrates how work begins long before June, starting with an early interest survey in September and moving step by step through call-out meetings, finalizing instructors, planning courses, and coordinating outreach. By the spring semester, attention shifts to logistics such as scheduling classrooms, opening registration, and preparing instructors through course-specific meetings. May is devoted to final confirmations, including reviewing enrollments, reserving facilities, and making public announcements. Finally, in the weeks just before the program launches, the team finalizes course rosters and makes adjustments as needed, ensuring that only viable courses move forward.

This cycle shows that FSM is not just a summer project but a year-round commitment that requires foresight, organization, and collaboration. The visual highlights the cyclical nature of the program, where each stage builds on the previous one and lessons learned from one summer inform the planning of the next. By the time students arrive in June and July, months of coordinated effort have already taken place, making it possible for the sessions to run smoothly. The figure underscores how the program's sustainability depends on this structured yet flexible planning process, with graduate students, administrators, and faculty advisors all contributing to the momentum that carries FSM from year to year.

Taken together, these steps highlight the careful planning and coordination required to sustain FSM year after year, and they set the stage for the pedagogical approaches described in the next section.

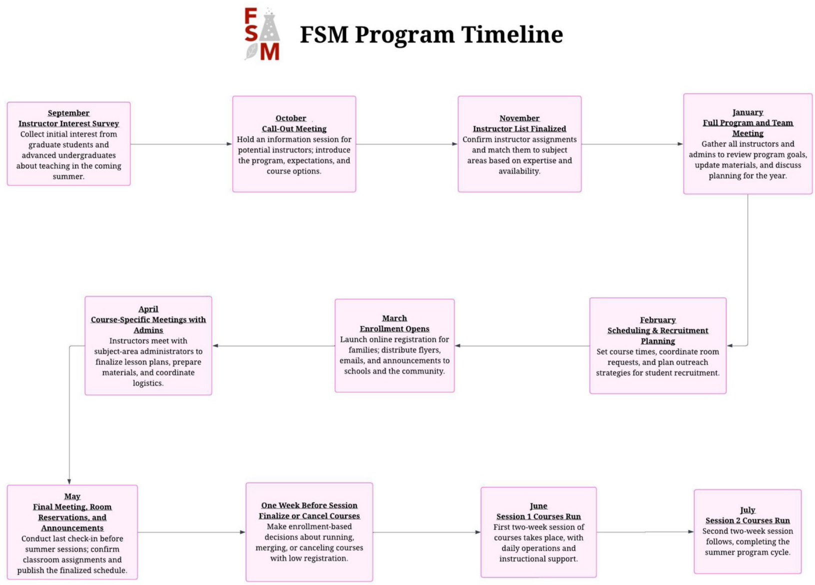

Figure 1. FSM Program Annually Timeline

Pedagogical Approaches

Instructional design in FSM is rooted in the belief that students learn best when they are active participants in the learning process. Rather than accelerating curriculum coverage or rushing through content, FSM seeks to create opportunities for students to explore STEM concepts in meaningful, low-pressure settings. The focus is on fostering curiosity, building confidence, and giving students the freedom to ask questions and pursue ideas. This orientation reflects broader shifts in STEM education, which increasingly emphasize inquiry, exploration, and identity development as central to effective teaching and learning (Fosnot, 2013; Windschitl, 2002).

The design of FSM courses is grounded in constructivist learning theory. Students are encouraged to build new understandings by connecting fresh ideas to what they already know, and by engaging in dialogue and collaborative activities with peers (Piaget, 1950; Vygotsky, 1978). Inquiry-based instruction is a central strategy in this regard, as it allows learners to investigate problems, gather evidence, and develop their own explanations. Such approaches have long been shown to be especially effective in STEM contexts, where active problem-solving and authentic application of knowledge are critical (National Research Council [NRC], 2000; Crawford, 2000).

One feature that sets FSM apart is its instructor base. Each summer, courses are taught primarily by PhD students and advanced graduate students in STEM or STEM education. These instructors bring both strong disciplinary knowledge and formal pedagogical training to their classrooms. Their teaching often reflects the principles of Pedagogical Content Knowledge (PCK) (Shulman, 1986), which emphasizes the ability to present subject matter in ways that make it accessible and engaging to diverse learners. Many also integrate digital tools through the framework of Technological Pedagogical Content Knowledge (TPACK) (Mishra & Koehler, 2006), making use of platforms such as Desmos, GeoGebra, and digital simulations to enhance visualization, interactivity, and student participation.

Preparation for teaching is taken seriously. While FSM does not require formal lesson plan submissions, instructors are expected to prepare a sequence of 12 instructional hours across the two-week session. These plans typically combine a mix of whole-class discussions, guided inquiry tasks, independent practice, and hands-on activities. To support this work, course administrators provide access to a shared archive of past syllabi, worksheets, projects, and lesson outlines. New instructors often adapt these resources, while returning instructors update and refine materials based on their previous experiences. Planning usually begins several months in advance, with mentoring and collaboration available from course administrators and faculty advisors.

A hallmark of FSM instruction is its intentionally low-stakes environment. Each course includes a pre-test and post-test, but these assessments are used only for program evaluation, never for ranking or grading students. The results give instructors insight into students' prior knowledge and growth, while also serving as feedback for the program as a whole. This approach aligns with formative assessment principles (Black & Wiliam, 1998), which emphasize learning progress over performance outcomes. It helps students view assessments as tools for growth rather than as sources of stress, and it allows instructors to adapt their teaching in real time to meet student needs.

Small class sizes usually three to six students further support individualized instruction. With such groups, instructors are able to build strong relationships with their students, tailoring explanations, pacing, and activities to the interests and levels of each learner. A typical class period might be divided into two 50-minute sessions with a short break in between, and instructors often end the day with an open Q&A or reflection period.

These closing moments provide students with space to voice lingering questions and to consolidate their learning in conversation with peers and instructors.

While FSM courses do not require capstone projects or final presentations, many instructors incorporate group-based investigations, lab work, or mini-projects. For example, computer programming students might present a simple app or game they designed, while biology students may share results from a lab experiment. Courses that involve labs, such as chemistry and biology, are supported with appropriate facilities, equipment, and safety protocols, ensuring that students have authentic exposure to scientific practices. The integration of digital and physical manipulatives also allows students to engage STEM concepts through multiple modalities.

Collaboration and professional community are also key features of FSM pedagogy. Instructors are encouraged to visit one another's classes, exchange ideas, and share resources. Course administrators often facilitate this cross-pollination by organizing informal check-ins and by making sure instructors have access to a common pool of teaching materials. This culture of openness allows instructors to learn from each other's successes and challenges, and it fosters a sense of belonging within the program.

Ultimately, FSM's pedagogical approach reflects a commitment to accessible, research-informed instruction that remains flexible and responsive to the needs of students and instructors alike. By centering active learning, inquiry, and community, FSM creates a model of summer STEM education that is not only academically rigorous but also deeply human one that cultivates intellectual growth while nurturing enthusiasm and confidence in the learners who participate.

Leadership and Coordination

One of FSM's distinguishing features is that, while it serves middle- and high-school students, it is coordinated end-to-end by graduate students from STEM and STEM-education fields. This graduate-student–led arrangement has underpinned the program's longevity: it creates authentic leadership roles planning the schedule, matching instructors to courses, communicating with families, and coordinating with departments while keeping curriculum and instruction anchored in current disciplinary knowledge and sound pedagogy. In practice, the model gives emerging scholars real responsibility and keeps the program nimble, responsive, and academically rigorous.

A Distributed Leadership Model

Each year, FSM is directed by at least one graduate student who serves as the Lead Coordinator. In some years, this individual is joined by a co-lead or a trainee coordinator who shadows the role in preparation for future leadership. The Lead Coordinator oversees the full scope of program operations from selecting instructors and finalizing course schedules to communicating with families and managing day to day logistics.

Supporting this role are Course Administrators, also graduate students, who specialize in specific content areas such as mathematics, science, or computer science. These course admins act as the primary point of contact for instructors in their discipline, helping to manage teaching materials, mentor less experienced instructors, and troubleshoot scheduling or organizational concerns.

Alongside graduate leadership, faculty advisors play a crucial but deliberately background role. They provide institutional oversight and ensure continuity, particularly by managing the program's budget, assisting with grant proposals, and preparing annual reports for sponsors. Faculty also maintain cross-campus partnerships and confirm that FSM adheres to university policies and safety requirements.

Program funding fluctuates from year to year and is drawn from a mix of sources, including the university, academic departments, and external grants (e.g., NASA and the Indiana Space Grant Consortium). Graduate student instructors are not directly involved in financial management. Instead, the Lead Coordinator submits updated rosters and course data, while faculty and departmental staff handle the administrative processing of stipends and reimbursements.

Planning Timeline and Instructor Coordination

Planning for the next summer begins almost immediately after the previous program ends. Once Session 2 concludes in July, the leadership team starts considering who might assume the coordinator role for the following year. Ideally, a successor is identified early so that they can shadow the current lead throughout the academic year, gradually learning the responsibilities and processes involved in running the program.

During the fall semester, FSM circulates an Instructor Interest Survey to graduate students in STEM-related departments as well as to past instructors. The survey collects details about subject expertise, availability, and potential course topics, providing an initial pool of candidates. Toward the end of the semester, the program hosts a call-out meeting where interested instructors are welcomed, program goals and expectations are explained, and logistical details are shared. This meeting also serves as an early step in aligning prospective instructors with possible courses.

When there is more than one applicant for a course, preference is typically given to those with relevant teaching experience or strong departmental ties. Returning instructors are also prioritized, both to recognize their contributions and to preserve continuity in instructional quality. New instructors, by contrast, may initially be placed in a reserve pool to serve as secondary teachers or as backups in case of scheduling conflicts or unexpected absences. This system has proven valuable for maintaining flexibility while ensuring that every class has adequate coverage.

By the start of spring, the roster of instructors is finalized, and specific course assignments are confirmed. Monthly meetings begin at this stage, giving instructors the chance to collaborate on course preparation, clarify program expectations, and coordinate outreach efforts. These meetings also provide a venue for experienced instructors and course administrators to share strategies, lesson materials, and insights from previous summers helping to build continuity while also allowing for innovation.

Coordinating Daily Operations

The smooth operation of FSM during the summer sessions is the result of both careful advance planning and strong, ongoing communication among all participants. Each session begins with a registration day, during which instructors staff a welcome desk in the program's main building. Here, families are greeted in person, consent forms are collected, and students are guided to their classrooms. This initial point of contact not only sets a professional and organized tone for the program but also reassures families that their children are entering a safe and supportive learning environment.

Throughout the summer, the lead coordinator is physically present on-site to address any emerging issues as they arise. Whether the concern involves classroom access, a student's unexpected absence, technical challenges, or a last-minute scheduling adjustment, the coordinator provides a reliable point of leadership and support. Day-to-day communication between instructors and the lead team takes place through multiple channels including email, in-person conversations, phone calls, or text messages ensuring that no issue is left unresolved for long.

Collaboration among instructors is also actively encouraged. In cases where a course has only one registered student, a second instructor is assigned to satisfy university supervision requirements. In these situations, the second instructor often contributes as a collaborator or observer, which not only maintains compliance but also provides the student with a richer educational experience. Course administrators, who oversee the broader subject areas of math, science, and computer science, check in regularly with instructors to offer pedagogical advice, provide additional teaching resources, and troubleshoot logistical challenges.

Together, this layered structure of coordinators, course admins, and instructors ensures that daily operations are both flexible and reliable. The emphasis on open communication and shared responsibility reflects FSM's broader philosophy: the program thrives not only because of individual contributions but also because of the collective support and collaboration among its teaching community.

External Communication and Institutional Support

Clear and consistent communication with families and university partners is essential to FSM's success. To streamline this process, the program maintains a dedicated email account, monitored daily by the lead coordinator during the summer months. All official inquiries from parents, students, or university staff are funneled through this account to ensure timely and accurate responses. Families typically receive a welcome email both from the program and from their child's instructor before the session begins. These messages include practical details such as classroom locations, daily schedules, contact information, and any required forms. Once classes are underway, instructors serve as the first point of contact for families regarding student progress or classroom concerns, while the coordinator remains available for broader logistical or administrative issues.

On the institutional side, FSM collaborates closely with several units across Indiana University. IU Conferences provides vital support for handling registrations, billing, and financial records, while departments such as Physics, Chemistry, and Biology help secure access to laboratories, specialized equipment, and technical resources. Faculty staff are often instrumental in coordinating these arrangements, particularly when purchases need to be made with external grant funding or when reporting requirements must be met. To avoid scheduling conflicts, space reservations are submitted at least one month in advance, and strong relationships with campus departments have helped FSM consistently secure the classrooms and labs it needs.

The program's collaborative leadership model ensures that these responsibilities are distributed effectively. Lead coordinators oversee the flow of information, course administrators address subject-specific needs, faculty advisors safeguard compliance and budgetary oversight, and instructors maintain direct lines of communication with students and families. Through this division of labor, graduate students gain experience not only in course design and teaching but also in program administration, financial coordination, and institutional partnership-building. These skills extend well beyond the scope of FSM and prepare participants for future roles in academic leadership, educational program management, and community engagement. In this way, FSM's external communication and institutional support structures do more than keep the program running smoothly they also model the kind of professional collaboration and organizational transparency that graduate students will encounter in their careers.

Reflections from Program Leaders and Instructors

Lead Author Reflection

My journey with the Foundations in Science and Mathematics (FSM) program began in Spring 2021, during the first year of my PhD studies. A colleague who served as the mathematics course administrator invited me to consider teaching in the summer program. With five years of experience as a high school mathematics and geometry teacher in Türkiye, I was drawn to FSM's goal of increasing high school students' interest in STEM. I applied and was assigned to teach the Standardized Test Review course, commonly referred to as SAT Preparation. That summer marked the beginning of my enduring relationship with FSM.

For the first two years (2021–2022), I participated as an instructor. In 2023, I transitioned into a leadership role as the mathematics course administrator. This role involved coordinating math instructors, facilitating communication, and managing course-related logistics. Thanks to this responsibility, I worked more closely with the FSM coordinator, and as they prepared to graduate, I was invited to shadow them. I served as co-coordinator in 2023 and took on full coordination responsibilities in 2024. I continue to serve as the FSM coordinator in 2025, and I will mentor the incoming coordinator next year before graduating.

My instructional experience in FSM reflects my desire to teach a range of math courses. I taught Standardized Test Review, Algebra 1, Geometry, and Precalculus, adjusting and enhancing the curriculum each year. My instructional goals have included increasing student engagement through technology (e.g., Desmos, GeoGebra), adapting problem-solving strategies from my experiences in Türkiye, and helping students build mathematical confidence. My prior work with test preparation centers and textbook writing in Türkiye also shaped my approach to SAT strategies. FSM provided an opportunity to refine these practices, and I incorporated self-study elements to document my growth as both a teacher and a researcher.

FSM has also allowed me to appreciate the unique challenges of teaching students from diverse grade levels (e.g., both 7th and 9th graders in an Algebra 1 class), requiring differentiated strategies. Unlike undergraduate teaching at the university, FSM offered real-time classroom experiences with younger learners and supported my understanding of the U.S. secondary curriculum. Teaching in a culturally and linguistically diverse environment also enriched my teaching and allowed me to promote equity in the classroom.

As a leader, FSM helped me grow in several ways. While I had prior leadership experience in student organizations and conferences, FSM allowed me to lead within an instructional context working with instructors, faculty, families, and students. I learned how to coordinate with university faculty, manage program logistics, and mentor new instructors. I also strengthened my communication skills with local teachers and school administrators, especially during outreach and recruitment.

One challenging moment was building the teaching schedule. Balancing instructor availability with student needs and course offerings was not always easy. I realized that being a leader meant making decisions that might not please everyone but ultimately served the program's goals and ensured fairness. Another challenge involved supporting students who struggled with payments. Initially unsure of the protocol, I learned that FSM prioritized accessibility over revenue and was empowered to grant scholarships. These moments deepened my sense of responsibility and trust in collaborative decision-making.

I found that clear task delegation and shared responsibilities fostered a strong team dynamic. Many of our instructors were PhD students like myself, and our mutual respect allowed us to collaborate effectively. I made a conscious effort to be approachable and present responding to emails, attending sessions, and contributing alongside others. Rather than directing from above, I worked alongside the team. This collaborative leadership style helped sustain a sense of shared ownership and motivation.

FSM significantly shaped my professional identity. The program complemented my doctoral coursework and research by providing a hands-on teaching and leadership platform. I believe FSM has helped me become a more reflective educator and a more empathetic leader. It strengthened my understanding of high school curricula in the U.S., particularly in comparison with my background in the Turkish education system.

Looking ahead, I aim to adapt FSM-style enrichment programs in Türkiye and beyond. STEM education is gaining importance globally, and summer programs like FSM can be powerful tools for outreach and innovation. With support from universities and local schools, and by incorporating technological tools such as Desmos and GeoGebra, we can create engaging, research-based summer learning environments. These programs can serve both students and teachers providing professional development and student learning opportunities simultaneously.

FSM taught me that good leadership involves balance: making fair, informed decisions even when they are difficult, and maintaining open communication. For new PhD students, I would strongly recommend FSM for several reasons: it allows you to apply your theoretical learning, improve your teaching skills, contribute meaningfully to high school students' education, build professional networks, develop leadership, and participate in a collaborative, research-oriented community. FSM is not just a summer job, it's a learning lab, a leadership incubator, and a space for meaningful connection.

Co-author Reflection

My journey as an instructor of FSM program began in the summer 2022, following a recommendation from senior colleagues in my Mathematics Education PhD program at Indiana University Bloomington. Prior to joining the program, I taught mathematics to middle and high school students in South Korea and Ethiopia for approximately four years. Wanting to build on this prior experience, I sought opportunities to teach secondary-level mathematics in the U.S. Fortunately, the FSM summer courses provided a valuable setting where I could engage with middle and high school students in a classroom environment. From 2022 to 2024, I taught precalculus and SAT preparation courses over three summers.

For SAT preparation course, I selected a textbook after reviewing several options from the library. I chose one that offered concise content reviews and a wide range of problems categorized by topic. I focused on key topics such as algebraic expressions, geometry, probability and statistics, devoting one topic per day. I aimed to have a balance between practicing problem-solving and understanding why math rules work. For instance, during the geometry unit, I included an activity where students explored why the sum of interior angles of a triangle is 180 degrees. Before the activity, I asked students what the sum was everyone responded with 180, but no one could explain why. To deepen their understanding, I provided various types of triangles labeled by name. Students cut out the triangles and arranged the pieces on a separate sheet of paper to see that the angles formed a straight line, demonstrating that their sum is 180 degrees. This hands-on activity helped students not only understand a well-known geometric fact but also review different types of triangles and their characteristics. I believe that the meaningful mathematical learning happens when students connect procedural knowledge or memorized facts to conceptual understanding.

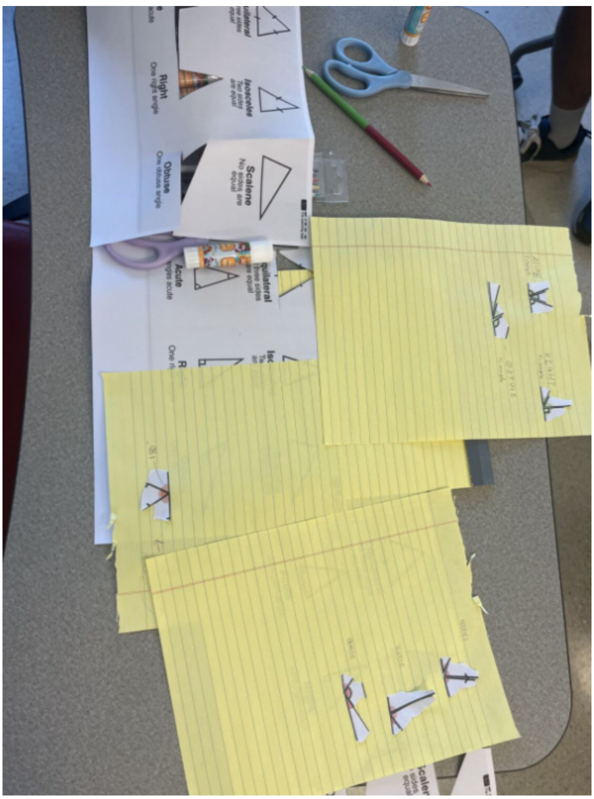

Figure 2. Geometry activity to prove the sum of interior angles of a triangle is 180 degrees

For precalculus courses, one instructional approach I would like to highlight is my active use of GeoGebra. In particular, I used it to support students' understanding of trigonometric functions. For example, when introducing transformations of the sine function, we explored how changed in an equation affect the graph. I asked students to compare various functions of by changing numbers of A, B, C, and D, focusing on identifying the amplitude and period. They could sketch the graph on their grid paper and then checked their graph by inserting the equations to GeoGebra. I also encouraged them to explain the role of the coefficient B in the equation. Through this visual and interactive activity, students were able to make meaningful connections between the algebraic form of the function and its graphical representation.

Additionally, I incorporated more student-led activities during class. One example was having students solve the same math problem by themselves on the blackboard in pairs, using chalk, and then present their solutions to the class. This structure allowed students not only to articulate their mathematical thinking through explanation but also to learn alternative problem-solving strategies by engaging with their peers' approaches.

As a common classroom context, there were various level of students in mathematics joined the same class. Sometimes, there were different grade level students joined the same course. To support all students according to their prior knowledge and mathematical background, I made it a priority to identify those students who needed additional help as well as those who were ready for more advanced challenges.

Pre-tests and pre-surveys played a crucial role in identifying students' backgrounds and levels in math. Administered on the first day of class, they included problems aligned with the course topics and helped me gauge each student's mathematical readiness. The textbook I selected also supported differentiation as it included problems at various levels of difficulty. I assigned foundational problems for all students and reserved more challenging problems for those who demonstrated advanced understanding. When advanced students completed the basic problems quickly, I provided them with additional tasks to deepen their learning. Furthermore, I encouraged students to explain their mathematical reasoning to one another. This peer interaction helped refine their thinking and provided opportunities to extend their understanding through collaborative learning.

Overall, my experiences teaching in the FSM program over the past three summers have been meaningful and formative. They allowed me to bridge my prior teaching experience with new instructional strategies that support diverse learners in the U.S. classroom context. Through thoughtful lesson planning, use of technological tools like GeoGebra, and differentiated instruction based on students' needs, I have grown in my ability to foster conceptual understanding and student engagement in mathematics. These teaching opportunities have strengthened my commitment to student-centered teaching practices, which I will continue to carry forward in my future work as a mathematics educator.

Implications and Future Directions

The Foundations in Science and Mathematics (FSM) program offers several unique contributions to STEM education that distinguish it from other summer enrichment programs. One of the most significant features of FSM is its instructional model, which centers around graduate student instructors, many of whom are doctoral students actively engaged in research in mathematics, science, or computer science education. These instructors bring cutting-edge disciplinary knowledge and pedagogical innovation into the classroom, delivering instruction that is both aligned with high school curricula and enriched by advanced academic perspectives.

FSM courses are carefully designed to balance the academic goals of reinforcing school content and introducing students to novel strategies and tools. For example, geometry instruction often incorporates digital tools such as Desmos and GeoGebra, which enable visualizations and interactions beyond what is possible in traditional settings. These tools not only help deepen students' conceptual understanding but also reflect the instructors' own research-based pedagogical development.

Equity and innovation are also key pillars of FSM's approach. The program is open to all students regardless of race, gender, or socioeconomic background, and instructors strive to adapt lessons to meet the varying needs and prior knowledge levels of participants. Pre-tests, in-class observations, and formative assessments help instructors provide more tailored instruction within the program's short two-week window. Innovation also stems from the instructors' roles as teacher educators and researchers, allowing them to implement and experiment with new instructional strategies that reflect current trends in STEM pedagogy.

The FSM model also offers transferable practices that could inform similar programs elsewhere. Its structure, which has been sustained over 15 years, could serve as a replicable model for short-term STEM camps focused on specific disciplines like math, science, or computer science. The dual-session summer schedule (June and July) gives families flexibility and allows some students to return for a second course. FSM's hybrid model developed during the COVID-19 pandemic further increased accessibility, particularly for courses where online delivery is feasible and effective, such as mathematics or programming.

Some of the most adaptable features of FSM include its use of doctoral students as instructors, the provision of university classroom spaces to introduce high school students to college environments, and a commitment to accessibility through financial support and scholarships. FSM's student-centered pedagogy, which emphasizes discovery and exploration, is consistent with contemporary educational values and can be extended to diverse settings.

Looking ahead, the future vision for FSM includes the continued offering of core STEM courses while integrating emerging topics. Recent additions such as Coding in Python and Viruses in Our World exemplify how the program responds to students' evolving interests and global developments. Future expansions may include topics like artificial intelligence and data science, as instructors bring their specialized knowledge to bear on course design.

FSM's structural and pedagogical development continues to evolve. The program encourages instructors to refine and personalize their lesson plans while drawing on shared curricular resources. Graduate instructors who are experts in their fields enrich the teaching and learning experience with their advanced content knowledge and ongoing research.

FSM has also had a significant impact on the professional development of its instructors. For many, the program serves as a laboratory for applying and reflecting teaching strategies, including those focused on student engagement, equity, and the integration of technology. Leadership roles, whether as course administrators or coordinators, further develop organizational and communication skills essential for future academic careers.

From a research standpoint, FSM provides fertile ground for educational inquiry. As a site for ongoing data collection through surveys, pre- and post-tests, and interviews, the program supports studies on students' STEM interests, instructional effectiveness, and program impact. Direct interaction with students and families also helps overcome challenges commonly faced by graduate student researchers in recruiting participants for studies. For example, instructors have used FSM as a site for self-study using frameworks like Mathematical Quality of Instruction, or for piloting methods they will later use in preservice teacher education.

In sum, FSM represents a vibrant, evolving model of summer STEM enrichment that blends academic rigor, equitable access, and pedagogical innovation. Its long-term sustainability and adaptability make it a compelling blueprint for similar initiatives in other local, national, or international contexts.

Conclusion

The Foundations in Science and Mathematics (FSM) summer program at Indiana University exemplifies what a sustainable, student-led STEM outreach initiative can accomplish when built on collaboration, intentional design, and reflective leadership. Over its 15-year history, FSM has served as a bridge between university resources and local middle and high school students, offering them a glimpse into the academic world of science, technology, engineering, and mathematics in an accessible and enriching way. At its core, FSM has generated significant educational benefits for all involved. Students are introduced to graduate-level STEM instructors and university settings in a low-stakes environment that fosters curiosity rather than anxiety. Free from the pressures of grades or exams, participants gain early exposure to advanced content and new pedagogical approaches, which often reshapes their attitudes toward learning and their aspirations for higher education. These encounters with doctoral-level educators, many of whom bring global perspectives as international students broaden students' understanding of what STEM can look like and who it is for. FSM has also offered invaluable professional development for instructors. For many graduate students, FSM is their first opportunity to independently design and teach a course, implement instructional strategies, and engage with youth in a sustained educational setting. Teaching middle and high school learners allows instructors to apply theoretical knowledge in real time and reflect on their practice. These experiences not only contribute to their development as educators and researchers but also cultivate leadership and organizational skills critical for future academic and administrative roles. The program's longevity is no coincidence. FSM's sustainability has been driven by a continuous mentorship model in which outgoing leaders train their successors, strong university support, dedicated instructors who believe in the mission, and families who return year after year. Access to small grants and institutional partnerships has also been key to supporting instructors financially and ensuring that the program remains affordable or free for students. This coordinated effort between university departments, graduate students, schools, and families has ensured that FSM remains deeply rooted in the local community while also scalable and adaptable. From a research perspective, FSM offers a unique environment for studying STEM education practices in action. Its flexible structure allows instructors to pilot innovative teaching methods, gather data, and reflect using various theoretical frameworks, such as self-study or the Mathematical Quality of Instruction (MQI) framework. The ease of reaching diverse student populations, including those underrepresented in STEM, makes FSM a rich site for exploring student engagement, learning outcomes, and pedagogical design. Several studies have already used FSM as a research context, and future opportunities especially those integrating qualitative interviews, observations, and new assessment frameworks are abundant. Looking forward, FSM holds promise not only as a continued summer enrichment program but also as a model for other institutions and regions. With appropriate institutional backing, similar programs could be adapted in universities across the world, including in Türkiye, where graduate students and faculty could build community-engaged outreach aligned with national STEM education goals. The hybrid format has increased reach, but instructors continue to advocate for face-to-face formats for certain courses particularly those requiring hands-on lab or fieldwork experiences. Ultimately, FSM serves as a reminder that STEM education reform does not solely depend on large-scale policy shifts. It can begin with a group of committed educators, a supportive institutional environment, and a shared vision for equity and engagement. The FSM model is not merely about delivering content it’s about building relationships, encouraging exploration, and shaping future educators and learners. Programs like FSM create space for collaborative, generative work that benefits all stakeholders and that, perhaps, is its most enduring contribution.

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