



S-STEM REC



Guidebook for Preparing Research and Evaluation Plans for NSF S-STEM Grant Proposals

Acknowledgments

This guidebook was developed through the Scholarships in Science, Technology, Engineering, and Mathematics (S-STEM) Resource and Evaluation Center (REC), which aims to create a greater infrastructure, build community, coordinate work, and synthesize findings across the hundreds of National Science Foundation (NSF) sponsored S-STEM programs at colleges and universities across the U.S. The S-STEM REC is supported through a cooperative agreement with the American Association of the Advancement of Science from the National Science Foundation under DUE-2224093. Any opinions, findings, interpretations, conclusions, or recommendations expressed in this material are those of its authors and do not necessarily represent the views of the AAAS Board of Directors, the Council of AAAS, AAAS' membership, or the National Science Foundation.

The guidebook is intended to serve as a reference and should not be considered a substitute for the NSF S-STEM program's guidelines or requirements. Users should refer to the program documentation for detailed, program-specific information. Readers should consult the NSF S-STEM solicitation for specifics on the NSF S-STEM program requirements and guidelines.

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Main Authors

MN Associates, Inc., Evaluation Technical Assistance providers of the AAAS S-STEM REC

Website: www.mnassociatesinc.com

Kavita Mittapalli, Ph.D.

Peter Goldie, (Ph.D.)

Nina de las Alas

Primary author contact: kavita@mnassociatesinc.com

Credit: MN Associates, Inc. (MNA) (2025). Guidebook for Preparing Research and Evaluation Plans for NSF S-STEM Grant Proposals. AAAS S-STEM REC. Available at:

<https://sstemrec.aaas.org/resource/guidebook-preparing-research-and-evaluation-plans-for-nsf-s-stem-grant-proposals/>

Table of Contents

Introduction: Who Is This Guidebook For?	4
Chapter 1: Conducting a Needs Assessment	5
Chapter 2: Incorporating Evidence-Based Practices	17
Chapter 3: Designing Knowledge Generation and Evaluation Plans	30
Chapter 4: Developing and Using a Logic Model or Theory of Change	41

Introduction: Who Is This Guidebook For?

This guidebook is for anyone involved in planning, managing, or evaluating an NSF S-STEM grant. Suppose you're a Principal Investigator (PI) or Co-Principal Investigator (Co-PI) designing and overseeing an S-STEM program. In that case, this guide will help you understand how to identify your prospective or current S-STEM Scholars' needs and collect data to measure program success effectively.

Maybe you're a researcher or an evaluator trying to track the impact of an S-STEM grant's evidence-based practices and ensure they align well with the NSF S-STEM program's goals. Or perhaps you're a grant writer who needs to know the key elements to highlight in a proposal to make your application stand out. If you're working on an NSF S-STEM grant in any capacity, this short guide aims to provide practical steps to help you design, implement, and measure a meaningful S-STEM program.

Note: This guidebook is not a substitute for the NSF S-STEM program solicitation requirements and should be used as reference or supplemental resources to help you refine the proposal and/or measure the success of your awarded grant(s).

Let's dive in!

Chapter 1: Conducting a Needs Assessment

The Importance of a Needs Assessment for NSF S-STEM Proposals

Conducting a needs assessment before applying for an NSF Scholarship in Science, Technology, Engineering, and Mathematics (S-STEM) grant is a critical step in aligning your proposal with the specific challenges and opportunities of your target population. A robust needs assessment helps to identify gaps in student support, academic resources, and financial assistance—core areas that S-STEM grants aim to address. By tailoring your proposal to the unique needs of your students and institution, you can craft a more compelling, evidence-based case for funding. Such groundwork not only strengthens the relevance of your proposal but also enhances its potential for a sustainable impact on STEM retention, graduation rates, and workforce readiness.

Why Conduct a Needs Assessment?

A needs assessment acts as a roadmap, clarifying your starting point and destination. It provides the foundation for strategic program design, ensuring that activities/interventions are well-suited to the unique context of your institution and student body. By analyzing current conditions, challenges, and opportunities, a needs assessment helps to:

- **Identify Pressing Challenges:** Understand the most significant barriers faced by prospective S-STEM Scholars, such as financial instability, lack of academic preparedness, or limited access to career development resources.
- **Tailor Interventions:** Design targeted solutions that address specific gaps, improving program efficacy and outcomes.
- **Meet Institutional and NSF Goals:** Align program objectives with broader institutional missions and NSF priorities, such as increasing diversity in STEM fields and fostering workforce readiness.

Incorporating Evidence-Based Practices

The research underscores the importance of needs assessment in designing effective STEM programs. For example, studies have shown that targeted interventions addressing financial barriers significantly improve retention and completion rates among underrepresented groups in STEM

(Chen, 2013). Additionally, aligning institutional capabilities with student needs ensures that programs are feasible and impactful (Crisp, Nora, & Taggart, 2009).

Enhancing Proposal Competitiveness

Including a well-documented needs assessment in your proposal signals to reviewers that your institution has a clear understanding of its current practices, challenges, and opportunities. It also demonstrates your commitment to evidence-based program design and provides a strong foundation for evaluating program success.

Steps to Conduct a Needs Assessment

1. Define Your Scope

Begin by identifying the key areas relevant to your prospective S-STEM Scholars. Focus on current academic performance and gaps, financial barriers, career readiness, and other dimensions critical to STEM student success on campus. This focus will guide your data collection and ensure that the assessment remains actionable and relevant.

2. Determine Data Collection Methods

Gathering comprehensive data requires using a mix of methods, each offering distinct insights:

- **Surveys:** Collect quantitative data on student demographics, academic performance, and financial needs. Surveys provide broad coverage and are useful for identifying trends.
- **Focus Groups:** Engage students, faculty, and staff in discussions to uncover qualitative insights into challenges and opportunities. Focus groups allow for a deeper exploration of specific issues.
- **Interviews:** Conduct one-on-one interviews with key stakeholders, such as academic advisors and financial aid officers, for in-depth perspectives.
- **Existing Institutional Data:** Leverage data from institutional research offices, such as retention rates, graduation statistics, and student feedback. These data can highlight systemic patterns and inform program design.

Let talk more about the data collection methods

Surveys: Casting a Wide Net

Surveys are the “bread and butter” of data collection in a needs assessment. They allow for gathering extensive information from a large group quickly and efficiently. Whether distributed online, via email, or in paper form, surveys capture a range of quantitative and qualitative data on student experiences, perceptions, and needs.

Why Use Surveys?

Surveys are straightforward to design and distribute, making them highly scalable. They’re ideal for collecting broad trends and patterns across your target population, such as all prospective or current S-STEM Scholars at your institution. For example, surveys can reveal how many students face financial barriers or feel underprepared for STEM coursework. They also ensure anonymity, which can encourage participants to share honest feedback.

- **Example:** *A survey might ask students to rate their confidence in STEM subjects on a scale from 1 to 10, identify campus supports, services, and resources they’ve used, or highlight financial constraints impacting their educational goals.*

What’s the Catch?

Surveys can lack depth. Closed-ended questions, while efficient, may not capture the nuanced “why” behind responses. For instance, if students report low confidence in math skills, a survey alone may not explain whether this is due to inadequate prior preparation, poor instruction, or other factors. Additionally, response rates can vary widely, and without careful design, surveys risk bias or unclear questions that compromise data quality.

- **Tip:** Combine multiple-choice questions with open-ended ones to gain both breadth and depth in responses.

Reference: Dillman, Smyth, & Christian (2014) describe best practices for creating effective surveys that maximize response rates and data reliability in *Internet, Phone, Mail, and Mixed-Mode Surveys: The Tailored Design Method*.

Focus Groups: Digging Deeper Together

Focus groups bring together a small, diverse group of Scholars for a facilitated discussion about their experiences, challenges, and ideas. This method creates a collaborative environment where participants can build on each other's responses, often surfacing insights that might be missed in other methods.

Why Use Focus Groups?

Focus groups generate rich qualitative data and foster a dynamic exchange of ideas. They can uncover unexpected themes or issues, such as feelings of isolation among underrepresented groups in STEM. This interaction often provides more context to survey findings. For instance, if surveys indicate financial hardship, focus groups might reveal that students are unaware of specific scholarship opportunities.

- **Example:** *A facilitator might ask, “What challenges do you face balancing academic responsibilities with financial pressures?” Responses could highlight systemic issues like limited access to part-time jobs on campus, financial needs, mental well-being, and other issues.*

What’s the Catch?

Focus groups require careful planning and skilled facilitation to manage group dynamics, ensure balanced participation, and address sensitive topics. They’re also time-intensive and represent a small sample size, so findings may not generalize to the entire population.

- **Tip:** Conduct multiple focus groups with varied participants to capture a range of perspectives.

Reference: Krueger & Casey (2014) provide a comprehensive guide to planning and conducting effective focus groups in *Focus Groups: A Practical Guide for Applied Research*.

Interviews: The Personal Touch

Interviews offer a one-on-one approach to exploring personal stories, motivations, and challenges in-depth. These conversations can be structured (following a specific set of questions) or semi-structured (allowing for flexibility based on the participant’s responses).

Why Use Interviews?

Interviews provide unparalleled depth and context, making them ideal for understanding complex issues or unique student circumstances. For example, an interview with a first-generation STEM student might reveal challenges with navigating institutional resources or balancing family expectations.

- **Example:** *An interview might explore a student's journey from enrollment to graduation, focusing on barriers like imposter syndrome or lack of mentorship.*

What's the Catch?

Interviews are labor-intensive and challenging to scale. They require skilled interviewers who can probe responses while maintaining a conversational tone. Analyzing interview data can also be time-consuming, especially if dealing with open-ended responses.

- **Tip:** Use interviews to complement other methods, focusing on participants who represent unique or underexplored perspectives.

References: Kvale, S., & Brinkmann, S. (2009). *InterViews: Learning the Craft of Qualitative Research Interviewing* (2nd ed.). Sage Publications.

Seidman, I. (2019). *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences* (5th ed.). Teachers College Press.

Existing Data: Using What's Already Available

Institutional data provides a valuable starting point for understanding trends and challenges without additional data collection. This includes retention rates, GPA trends, financial aid usage, demographic data, and program outcomes.

Why Use Existing Data?

Existing data is readily available and cost-effective. Work with your Institutional Research (IR) staff member (also sometimes called the Institutional Effectiveness department). The data often offers insights into systemic issues, such as disparities in STEM retention or graduation rates among

different demographic groups. These insights can inform targeted interventions, like additional tutoring for at-risk populations.

- **Example:** Analyzing retention rates might show that first-year STEM students are more likely to leave their major, prompting a focus on first-year support services in your S-STEM proposal.

What's the Catch?

Existing data often lacks the personal context needed to fully understand student experiences. For instance, while GPA trends may highlight academic struggles, they don't explain whether these are due to financial pressures, inadequate resources, or personal challenges. Additionally, data quality may vary, and access to sensitive information may require institutional approval.

- **Tip:** Combine existing data with other methods like surveys or focus groups to provide a fuller picture.

Reference: Terenzini et al. (1996) emphasize the importance of integrating institutional data with qualitative insights in *Influences on Students' Learning*.

Bringing It All Together

Each data collection method has strengths and limitations, and the most effective needs assessments use a combination of tools. For instance, surveys can identify broad trends, focus groups can provide depth and context, interviews can uncover personal stories, and existing data can highlight systemic issues. By triangulating these methods, you can create a comprehensive understanding of your NSF S-STEM Scholars' needs, ensuring that your program design is both evidence-based and impactful.

Pro Tip: Use this chart to develop a needs assessment for your NSF S-STEM grant proposal.

Method	Description	Pros	Cons
Surveys	Distribute online or paper questionnaires to gather quantitative data on student experiences.	Easy to distribute; scalable.	Limited depth; may miss nuanced student experiences.
Focus Groups	Conduct group discussions with selected Scholars to dive deeper into their needs.	Provides rich qualitative data; reveals unexpected issues.	Time-consuming; requires skilled facilitation.
Interviews	One-on-one discussions with Scholars, faculty, or staff.	Deep insights; personal stories.	Labor-intensive; not suitable for large-scale data collection.
Existing Data	Use institutional data (e.g., retention rates, GPA trends, financial aid usage).	Already available; no extra effort is needed to collect.	Might not capture all relevant information or student perspectives.

Analyze the Data

Analyzing data from a needs assessment involves breaking down both quantitative and qualitative information to identify trends, patterns, and actionable insights. This step ensures that the collected data informs evidence-based decision-making for your S-STEM program, and they can act as goal posts against which you can measure progress toward project success.

1. Use Statistical Tools to Identify Trends and Patterns

Quantitative data from surveys and existing records can reveal overarching trends and correlations.

- **Example:** Statistical analysis may show that students with financial aid gaps are more likely to withdraw from STEM programs.
- Tools like **Excel**, **SPSS**, or **R** can be used to calculate frequencies, averages, or correlations, while visualization software like **Tableau** and **R** can create compelling charts to highlight these patterns.
- Advanced techniques such as **regression analysis** can help pinpoint factors most strongly associated with outcomes like retention or academic performance.

2. Conduct Qualitative Coding for Interviews and Focus Groups

Qualitative data from focus groups and interviews provides depth to complement quantitative trends.

- Use software like **NVivo**, **Dedoose**, or **ATLAS.ti** to code responses for recurring themes, such as “lack of academic mentorship” or “financial stress.”
- Highlight participant quotes that capture key insights to add richness to your report.
- **Example:** Coding might reveal that a significant number of students perceive a lack of accessible career guidance in STEM fields, which is not apparent in survey data alone.

3. Compare Findings with Existing Literature

Compare your results to prior research or institutional benchmarks to contextualize your findings.

- **Example:** If your data shows an underrepresentation of women in your STEM programs, cite existing studies, such as those by the U.S. Department of Education, National Academies of Sciences, and the NSF, to emphasize that this is a systemic issue requiring targeted activities/approaches or intervention.
- This step also helps identify whether your institution’s challenges align with broader trends or are unique to your institutional context, shaping the framing of your grant proposal.

Prioritize the Needs

Prioritization ensures that your S-STEM program focuses on the most critical and impactful areas, aligning with institutional goals and NSF priorities.

1. Urgency – How Critical is the Need for Student Success?

- Urgency refers to the immediacy of the need and its direct impact on student retention or success.
- **Example:** If a significant portion of your STEM students report being unable to afford the required STEM textbooks, this represents a critical need that impacts academic performance and should be addressed promptly.

2. Feasibility – Can You Realistically Address This Need with Your Available Resources?

- Evaluate whether you have the institutional capacity, staffing, and financial resources to tackle the identified needs.
- **Example:** Establishing a tutoring program may be feasible if your institution already has a learning center, but creating new lab facilities may require substantial external funding beyond the S-STEM grant.
- This analysis ensures that your proposal is practical and demonstrates an efficient use of funds.

3. Impact – Will Addressing This Need Significantly Improve Student Outcomes?

- Assess the potential of each need to contribute to measurable improvements in STEM retention, graduation rates, or workforce readiness.
- **Example:** Addressing a lack of mentorship might have a higher impact on long-term success compared to providing one-time financial workshops, as mentorship can foster sustained academic and career development.

How to Rank Needs

- Assign scores to each need under the criteria of urgency, feasibility, and impact.
- **Example:** Use a scoring system (e.g., 1 (low) –5 (high)) to rank the needs objectively and create a weighted priority list.
- Combine this quantitative ranking with stakeholder input to finalize priorities.

Additional References and Resources

General References on Needs Assessment

1. **Chen, X. (2013).** *STEM Attrition: College Students' Paths into and Out of STEM Fields.* Washington, DC: National Center for Education Statistics.
2. **Crisp, G., Nora, A., & Taggart, A. (2009).** *Student characteristics, pre-college, and environmental factors as predictors of majoring in and earning a STEM degree: An analysis of students attending a Hispanic Serving Institution.* *American Educational Research Journal*, 46(4), 924-942.

3. **Witkin, B. R., & Altschuld, J. W.** (1995). *Planning and Conducting Needs Assessments: A Practical Guide*. Sage Publications.
 - A foundational resource on designing and implementing needs assessments, applicable to educational and training programs.
4. **Gupta, K.** (2011). *A Practical Guide to Needs Assessment*. Wiley.
 - This book outlines the steps for conducting needs assessments in various organizational settings, including education.
5. **Altschuld, J. W., & Kumar, D. D.** (2010). *Needs Assessment: An Overview*. Sage Publications.
 - Provides a comprehensive framework for understanding and applying needs assessment methodologies.

Surveys

4. **Fowler, F. J.** (2014). *Survey Research Methods (5th ed.)*. Sage Publications.
 - Offers guidance on designing effective surveys, including question design, sampling, and data analysis.
5. **National Science Foundation (NSF).** (n.d.). **STEM Education Data and Trends**. Retrieved from NSF STEM Data
 - A valuable resource for understanding STEM education trends and benchmarking survey findings.

Focus Groups

6. **Krueger, R. A., & Casey, M. A.** (2014). *Focus Groups: A Practical Guide for Applied Research (5th ed.)*. Sage Publications.
 - A guide to organizing and conducting focus groups, including strategies for managing group dynamics and analyzing results.
7. **Morgan, D. L.** (1997). *Focus Groups as Qualitative Research (2nd ed.)*. Sage Publications.
 - Explores the use of focus groups for qualitative data collection and offers practical advice for implementation.

Interviews

8. **Kvale, S., & Brinkmann, S.** (2014). *InterViews: Learning the Craft of Qualitative Research Interviewing* (3rd ed.). Sage Publications.
 - Discuss effective interview techniques, including structured and semi-structured approaches.
9. **Seidman, I.** (2019). *Interviewing as Qualitative Research: A Guide for Researchers in Education and the Social Sciences* (5th ed.). Teachers College Press.
 - Focuses on in-depth interviewing, particularly in educational research contexts.

Existing Data

10. **Patton, M. Q.** (2014). *Qualitative Research & Evaluation Methods: Integrating Theory and Practice* (4th ed.). Sage Publications.
 - Discusses leveraging existing data as part of mixed-methods research and evaluation.
11. **U.S. Department of Education.** (n.d.). **IPEDS Data Center.** Retrieved from IPEDS
 - Institutional data on enrollment, retention, and financial aid can be accessed for benchmarking purposes.

Data Analysis

12. **Creswell, J. W., & Plano Clark, V. L.** (2017). *Designing and Conducting Mixed Methods Research* (3rd ed.). Sage Publications.
 - Offers strategies for integrating quantitative and qualitative data analysis.
13. **Miles, M. B., Huberman, A. M., & Saldaña, J.** (2014). *Qualitative Data Analysis: A Methods Sourcebook* (3rd ed.). Sage Publications.
 - Details methods for coding and analyzing qualitative data, such as focus groups and interview transcripts.
14. **IBM SPSS.** (n.d.). **Statistical Analysis Software.** Retrieved from IBM SPSS
 - Widely used for analyzing quantitative survey data.

Prioritization

15. **Kirkpatrick, D. L., & Kirkpatrick, J. D.** (2006). *Evaluating Training Programs: The Four Levels (3rd ed.)*. Berrett-Koehler Publishers.
 - Although focused on training programs, the prioritization strategies discussed are relevant for ranking needs in educational programs.
16. **McKillip, J. (1987)**. *Need Analysis: Tools for Human Services and Education*. Sage Publications.
 - A guide to prioritizing identified needs based on criteria such as urgency, feasibility, and impact.

Chapter 2: Incorporating Evidence-Based Practices

Once you have completed a needs assessment (see Chapter 1), the next critical step in creating an effective NSF S-STEM program is to incorporate Evidence-Based Practices (EBPs) that closely align with the identified needs of NSF S-STEM scholars at your institution.

What are EBPs?

EBPs are proven practices, interventions, factors, concepts, activities, strategies, or frameworks backed by data and research that have demonstrated effectiveness in improving learning outcomes in educational settings. They are grounded in empirical studies and data, often tested across diverse contexts to ensure reliability and adaptability. EBPs extend beyond individual activities or practices to include broader concepts and frameworks that guide the program's design and implementation. Incorporating EBPs ensures that the programs are not only innovative but also built on a solid foundation for success, leveraging research-driven approaches to address specific needs and achieve measurable outcomes (NCIL, 2028; USDE, 2016).

Key Attributes of EBPs

- **What Makes EBPs Reliable:**

EBPs are rigorously tested through controlled studies, longitudinal research, or meta-analyses, ensuring their validity and effectiveness across diverse educational settings. This reliability provides program leaders with confidence in their implementation.

- **Relevance in STEM Education:**

EBPs tackle core challenges such as low retention, limited engagement, and achievement gaps in STEM fields. Their application ensures that programs focus on actionable solutions aligned with real-world needs.

- **Adaptability to Unique Contexts:**

While EBPs provide a proven framework, their success depends on tailoring them to your institution's context and S-STEM Scholars' specific needs. For instance, mentorship programs can be adapted to emphasize the inclusion of underrepresented groups in STEM.

Examples of Commonly Used EBPs, Activities, or Enhancements in S-STEM Grants/Proposals

Practice or Intervention

- Proactive/Intrusive Advising
- Peer-Led Tutoring and Learning
- Living-Learning Community
- Undergraduate Research
- First Year Experience

Frameworks and Concepts

- Fostering Sense of Belonging
- Social and Intellectual Integration
- Internship Efficacy/Satisfaction
- Academic Life and General Program Satisfaction
- Academic and General Self-Efficacy
- Engineering Self-Efficacy
- Engineering and Computer Science Identity
- STEM Identity
- Imposter Syndrome Phenomenon
- Growth mindset

Examples of Impact

In STEM Education

- **Peer Mentoring Programs:**
Pairing first-year NSF S-STEM Scholars with upperclassmen provides role models and guidance, boosting retention rates by creating a supportive academic community.
- **Proactive Advising:**
Advisors who check in with NSF S-STEM Scholars regularly identify academic or personal

challenges early, providing timely interventions. This has been shown to reduce dropout rates.

- **Undergraduate Research Opportunities:**

Engaging NSF S-STEM Scholars in research projects improves critical thinking skills and increases their interest in pursuing STEM careers or graduate education.

In Holistic Development

- **Growth Mindset Training:**

Workshops and seminars that encourage NSF S-STEM Scholars to view challenges as opportunities to foster resilience and persistence, particularly in difficult STEM courses.

- **Social Belonging Initiatives:**

Activities like cohort-building events and living-learning communities create an inclusive environment where NSF S-STEM Scholars feel connected and supported.

- **Imposter Syndrome Interventions:**

Programs that address and normalize feelings of self-doubt help NSF S-STEM Scholars build confidence and achieve academic success.

Why Use EBPs?

Integrating EBPs into your NSF S-STEM proposal offers multiple advantages (and it's required!):

- **Demonstrate Effectiveness:**

EBPs have a track record of delivering measurable improvements in retention, performance, and career readiness among STEM students.

- **Enhance Credibility:**

Grounding your proposal in EBPs signals to reviewers that your program is innovative and informed by research.

- **Support Sustainability:**

The robust frameworks EBPs provide ensure that program benefits extend beyond the funding period, creating lasting impact.

- **Increase Proposal Competitiveness:**

Proposals that incorporate proven strategies have a higher likelihood of NSF support, as they align with expectations for evidence-based program design.

Using EBPs

1. **Align Interventions with Needs:** To ensure that the interventions you develop or adopt for an NSF S-STEM program are effective, it is crucial to align them with the specific needs identified in your initial needs assessment (see details in Chapter 1).
For example, if your needs assessment reveals that many students on your campus feel disconnected or isolated, you might prioritize creating structured opportunities/activities for social and intellectual integration, such as implementing cohort-based activities or adopting Living-Learning Communities. These activities/interventions foster a sense of belonging by helping students build meaningful relationships with peers and faculty, creating a supportive environment that encourages persistence in STEM fields. By addressing these needs directly, your NSF S-STEM program can cultivate a stronger sense of community and belonging, which are critical for student persistence, retention, and success.
2. **Leverage Existing Research:** When designing your NSF S-STEM program, it's beneficial to leverage existing research on proven methods that have worked elsewhere. For instance, mentoring programs have been shown to enhance academic self-efficacy and STEM identity among students, particularly those from underrepresented groups. By implementing a structured mentoring initiative, where faculty members guide Scholars in setting academic and career goals, navigating challenges, and accessing resources, you can create a supportive framework grounded in evidence-based practices. Such programs not only strengthen student-faculty connections but also empower students to see themselves as capable and successful STEM professionals, increasing their likelihood of persisting in STEM pathways.
3. **Customize Practices for Your NSF S-STEM Scholars:** While EBPs offer valuable guidance, it's important to customize these practices to fit the unique circumstances of your prospective or current S-STEM Scholars. For example, if mentorship programs have proven successful in other institutions, consider adapting the model by pairing Scholars with mentors who share

similar backgrounds or career aspirations. Customizing EBPs in this way ensures that Scholars receive support that is not only effective in theory but also personally relevant and relatable, increasing their likelihood of engaging fully with the program.

4. **Pilot and Refine:** Before fully implementing a new program, starting with a pilot can help identify areas for improvement. By launching a small-scale version of the program, you can gather valuable feedback from participants and make necessary adjustments. This approach allows you to refine the intervention based on real-world data and participant experiences, ensuring that when you scale up, your program is well-tuned to meet Scholars' needs and is more likely to achieve desired outcomes.

Pro tip: Examples of EBPs Based on Needs Assessment Findings

Identified Need	EBP Example	How It Addresses the Need
Academic Support	Peer Tutoring Programs	Provides tailored academic help and builds peer networks.
Financial Literacy	Workshops on Budgeting and Financial Planning	Helps Scholars manage funds effectively, reducing stress.
Career Readiness	Industry-Specific Mentorship Programs	Connects Scholars with professionals for guidance.
Feeling of Disconnection and Isolation	Learning Communities and Cohort-Building Activities/Events	Encourages social interaction and collaborative learning.

Expanding the List of 16 Key EBPs

In addition to the 16 EBPs outlined earlier, consider integrating practices like:

- **Cultural Competence Training:**
Programs that train faculty and mentors to address cultural and social barriers faced by underrepresented students in STEM fields.
- **Industry Partnerships for Internships:**
Collaborating with local businesses to offer hands-on learning experiences, giving students insight into STEM careers while enhancing their resumes.

- **Career Navigation Tools:**
Providing resources and workshops to help students map their career paths in STEM, including resume writing and mock interviews.

Supporting Resources and Future Directions

How Were These EBPs Identified

EBPs were compiled through an extensive review of NSF S-STEM program abstracts and current research literature, as well as consultations with program leaders.

Why These EBPs Matter

Research confirms the significant impact of EBPs on STEM Scholars. Programs that incorporate strategies such as proactive advising and activities/engagement strategies that increase sense-of-belonging have reported improved retention, graduation rates, and post-graduation outcomes.

How to Use the EBPs List Effectively

- Visit [AAAS S-STEM REC Resources](#) for tools and measures to implement and assess EBPs.
- Tailor the EBPs to your institution's specific context to address challenges effectively.

Pro Tip: Build a Feedback Loop

Engage students, faculty, and other stakeholders in ongoing evaluations of EBPs. Their input can uncover hidden challenges or provide innovative ideas for further improvement.

Case Study: A Successful EBP in Action

Program Example: A Proactive Advising Initiative at [Institution Name]

- **Challenge:** First-generation S-STEM Scholars were struggling with course selection and career planning.
- **Solution:** Implementing proactive advising sessions every semester. Advisors collaborated with faculty to identify at-risk students and provide tailored support.

- **Outcome:** Retention rates increased by 15%, and students reported higher levels of satisfaction with academic guidance.

By incorporating, adapting, and continuously improving EBPs, your NSF S-STEM program can create a transformative experience for Scholars, ensuring academic success and career readiness.

How to Access Resources for These EBPs on the REC Website

Explore the tools, measures, and research behind each EBP on the AAAS S-STEM REC website:

1. Visit the resources page at <https://sstemrec.aaas.org/resources/>
2. Use the filters to search by EBP or select “Evidence Based Practices” under “Types”.
3. Dive deeper into the strategies and instruments that align with your program’s goals.

Pro tip: Webinar

For a comprehensive walkthrough of these EBPs and the tools to measure their impact, check out our webinar held on **July 25th, 2024**. The presentation slides and recording of the webinar can also be found on the [website](#). During the webinar, we discussed how to integrate EBPs effectively into your S-STEM proposal and access valuable resources to support your Scholars. The S-STEM REC website also includes EBP repositories.

To [access the repositories](#), click on the topic you are interested in and then scroll down to DOWNLOAD the list of research article references, all of which have measures/tools – some qualitative - that you can search and access. Unfortunately, many measures/tools were not readily accessible in the grant abstracts and most of them are only accessible through a paywall. However, many of you can easily access the measures/tools via your institution’s online library. Each data sheet includes article type, author(s), APA reference, publication date, DOI, target participants, keywords, abstract, and if the tool is a validated scale or not.

If you have other EBPs that could be included in the list, please [share](#) them with us!

Sample EBP repository data sheet

Article Title	Author	APA reference	Publication Date	DOI	Participants (Population)	Keywords	Abstract	Validated tool (Y/N)
Evaluating the First Year Experience: Students' Knowledge, Attitudes, and Behaviors	Schrader, PG; Brown, Scott W	Schrader, P. G., & Brown, S. W. (2008). Evaluating the first year experience: Students' knowledge, attitudes, and behaviors. <i>Journal of Advanced Academics, 19</i> (2), 310-343. https://doi.org/10.4219/jaa-2008-775	2008	https://doi.org/10.4219/jaa-2008-775	First year university students	first year experience, undergraduate students, adjustment to college, university, college	Research has found that many students who enroll in college do not graduate. To remedy this, many universities have implemented interventions such as first year experience programs, which seek to ease difficulties with transitioning to college. The current study evaluates a first year experience program at a large university. The authors assessed students' outcomes related to knowledge, attitude, and behavior. Students responded to questions on a 5-point Likert-type scale. The results indicated that the effects of this particular first year experience were quite small, suggesting that it may have had limited effectiveness. The full set of questions assessing first year students' experiences (in these three	Y
2024 Your First College Year Survey	University of California	University of California. (2024). <i>2024 Your First College Year Survey</i> . Author. https://heri.ucla.edu/your-first-college-year-survey/	2024	N/A	N/A; no study associated with this instrument. Designed for use with college students.	first year experience, higher education, student engagement, undergraduate experience	This survey was developed to assess aspects of first year experiences that facilitate positive outcomes (e.g., learning, satisfaction, retention). Most of the questions on the survey are multiple-choice.	Y
National Survey of Student Engagement	Indiana University	Indiana University. (n.d.). <i>National Survey of Student Engagement</i> . Author. https://nsse.indiana.edu/nsse/	n.d.	N/A	N/A; no study associated with this instrument. Designed for use with college students.	first year experience, higher education, student engagement, undergraduate experience	activities that intend to foster learning and development. The results show levels of student engagement. Although it is not solely for use with first-year students, it can be used to capture these students' experiences.	N
First year experience: How we can better assist first-year international students in higher Eeducation.	Yan, Zi; Sendall, Patricia	Yan, Z., & Sendall, P. (2016). First year experience: How we can better assist first-year international students in higher Education. <i>Journal of International Students, 6</i> (1), 35-51.	2016	N/A	First year intentional undergraduate students in the US	first year experience, higher education, undergraduate students, international students	supportive course or program to ease first year students' transitions to college. However, these programs may not often meet the unique needs of international students. The present study examined the efficacy of such a program tailored for international students. Included in the study is a 15-item measure of the outcomes of first year experience courses (Table 2, p. 39). This measure is tailored to international students' experiences, but may be appropriate for use with other students upon	N

In sum, when developing or adopting EBPs for an NSF S-STEM program, it is essential to ensure they are aligned with the specific needs of your Scholars while leveraging proven strategies from research. Whether you are introducing new interventions or customizing existing practices, focusing on evidence-based approaches helps create a program that is both effective and tailored. By grounding your efforts in research, adapting them to fit the unique context of your Scholars, and refining them through pilot testing, you increase the likelihood of fostering academic success, career readiness among STEM Scholars.

By leveraging these or other EBPs, you can design an S-STEM program that not only addresses the unique needs of your students but also stands out as a strong, evidence-based proposal in the eyes of NSF reviewers.

Creating an Archetypical NSF S-STEM Scholar

Evidence-based, context-specific interventions, practices, or frameworks must be linked to low-income student needs. All NSF S-STEM projects must build their project on needs analyses specific to the targeted population of low-income students in the proposed disciplines.

But how do we do this?

(Also, refer to Chapter 1 on conducting a needs assessment for details.)

Creating an archetype S-STEM Scholar in your proposal is a powerful tool for keeping your program student-centered and focused on addressing the real needs of your target population. Much like developing a persona in marketing, this archetype represents the typical S-STEM Scholar you aim to support through your S-STEM grant. By grounding the archetype in your needs analysis and linking it to evidence-based practices (EBPs), you can design interventions that are not only relatable and relevant but also informed by proven strategies. This ensures that your program integrates EBPs effectively to address the specific challenges and opportunities faced by your Scholars, creating a cohesive and impactful proposal.

Meet Alex, Your Archetype NSF S-STEM Scholar!

Let's meet Alex, our fictional archetype NSF S-STEM scholar, who embodies the characteristics of Scholars your NSF S-STEM program seeks to serve. By developing this archetype, you can guide your program design and communicate more clearly with stakeholders about who your program is for and what kind of support it provides.

Profile of Alex:

Characteristic	Details
Background	Alex is a first-generation college student from a low-income family and is part of a group underrepresented in STEM fields.
Academic Interests	Alex is passionate about engineering, particularly renewable energy and sustainability. This interest drives Alex's goal of pursuing a career that makes a positive impact on the environment.
Challenges	Alex struggles with foundational math courses, which are crucial for success in engineering. Additionally, Alex feels isolated in a predominantly non-diverse program at their institution, which affects their sense of belonging and academic confidence.
Needs	To succeed, Alex requires financial scholarship support, targeted math tutoring, peer mentoring from others with similar backgrounds, and access to networking opportunities in STEM fields.

Why Create an Archetype?

Developing an archetype like Alex serves multiple purposes in your NSF S-STEM program. By putting a face to the types of Scholars your program is designed to support, you ensure that your interventions remain student-centered and focused, keeping the real challenges and needs of your target population in focus. Alex's profile highlights the key areas where support is needed, such as financial assistance, academic tutoring, mentorship, and community building, helping you to design initiatives that directly address these pain points.

Furthermore, the archetype helps you to communicate with stakeholders, such as faculty, funders, and industry partners, about the type of Scholars your program serves. By referencing Alex, you provide a concrete example that makes the needs and goals of your NSF S-STEM program more relatable and understandable. This helps build empathy and understanding among stakeholders, ensuring that everyone is aligned in their support of your scholars.

In essence, creating an archetype helps keep your NSF S-STEM program focused on delivering tangible, impactful solutions to real problems, while also making it easier to articulate your program's value to external audiences.

Measuring the Effectiveness of EBPs for Low-Income Talented S-STEM Scholars

Once EBPs are implemented, measuring their efficacy/effectiveness is crucial to ensure that interventions are delivering the intended outcomes. This systematic process, often referred to as the [Generation of Knowledge \(GoK\)](#) (or Knowledge Generation), involves collecting, analyzing, and interpreting data to measure the program's success. By doing so, stakeholders gain valuable insights into what's working, what needs adjustment, and how to sustain or scale the interventions.

To evaluate the impact of EBPs on low-income talented S-STEM Scholars, it is crucial to design a robust measurement framework that captures both qualitative and quantitative outcomes. Start by identifying specific metrics aligned with the goals of the EBPs, such as retention rates, GPA improvements, degree completion, and career readiness. Collect demographic data to ensure that the measurement captures the unique experiences and challenges of low-income Scholars. Use pre- and

post-intervention surveys to assess changes in Scholars' levels of confidence, sense of belonging, and self-efficacy that may lead to changes in learning outcomes. Additionally, include focus groups or interviews to gather nuanced feedback about the barriers Scholars face and how EBPs address them. Collaborate with the institutional research office to analyze existing data on financial aid usage and STEM program participation rates. This multi-faceted approach ensures that the evaluation not only tracks outcomes but also informs program refinement to better support low-income S-STEM Scholars.

Setting SMART Goals and Metrics

Creating clear, actionable goals is the first step in measuring success. SMART goals provide a framework to ensure objectives are:

- **Specific:** Define exactly what you aim to achieve.
- **Measurable:** Use quantifiable metrics to track progress.
- **Achievable:** Set realistic targets that align with available resources.
- **Relevant:** Ensure alignment with identified needs and program objectives.
- **Time-bound:** Establish a clear timeline for achieving goals.

Example of a SMART Goal

- **Specific:** Increase participation in tutoring programs by 20%.
- **Measurable:** Track the number of Scholars attending tutoring sessions.
- **Achievable:** Ensure sufficient tutors, space, and schedules to support growth.
- **Relevant:** Address the identified gap in academic support for STEM Scholars.
- **Time-bound:** Achieve the target within the first academic year.

Methods to Collect and Analyze Data

Data collection and analysis are essential to understand the effectiveness of EBPs and guide decision-making. The table below outlines key metrics, data sources, frequency of collection, and their purpose.

Metric	Data Source	Frequency	Purpose
Retention Rates	Institutional data	End of each semester	Evaluate overall program success by tracking student persistence.
Student Grades (GPA)	Academic records	Every semester	Assess academic improvement over time.
Program Satisfaction	Surveys, focus groups	Biannually	Gather qualitative and quantitative feedback to identify improvement areas.
Employment Outcomes	Alumni surveys, career services data	Annually	Measure post-graduation career readiness and job placement success.

Detailed Insights on Methods

- **Retention Rates:**
Use longitudinal analysis to track year-over-year retention trends among Scholars, comparing them to non-participants for context.
- **Student Grades (GPA):**
Conduct pre- and post-intervention analysis to determine the impact of EBPs like tutoring or faculty mentoring on academic performance.
- **Program Satisfaction:**
Combine open-ended survey responses with focus group discussions to uncover quantitative trends and in-depth feedback.
- **Employment Outcomes:**
Collaborate with alumni networks and career services to track metrics such as time-to-employment, job alignment with STEM fields, and salary benchmarks.

Analyzing the Data

1. **Quantitative Analysis:**
 - Apply statistical tools such as regression analysis or ANOVA to identify patterns, trends, and causal relationships.
 - Create dashboards or reports to visualize key performance indicators (KPIs) over time.

2. Qualitative Analysis:

- Use coding frameworks for thematic analysis of focus group or interview data, highlighting recurring themes or unique insights.
- Map qualitative findings to quantitative metrics for a holistic understanding of program impact.

Leveraging Results for Improvement

Once the data is analyzed, use the findings to:

- **Refine EBPs:** Adjust strategies to address gaps or enhance successful elements.
- **Report Outcomes:** Share results with key stakeholders, including the NSF, institutional leaders, and community partners, to demonstrate the program's efficacy.
- **Inform Future Proposals:** Use insights to craft stronger, evidence-backed proposals for continued or expanded funding.

By continuously measuring and analyzing the success of EBPs, NSF S-STEM programs can create a cycle of improvement that ensures long-term benefits for S-STEM Scholars and institutional growth.

References

National Center on Improving Literacy (2018). What do we mean by evidence-based? Washington, DC: U.S. Department of Education, Office of Elementary and Secondary Education, Office of Special Education Programs, National Center on Improving Literacy. Retrieved from

<https://www.improvingliteracy.org>

Non-Regulatory Guidance: Using Evidence to Strengthen Education Investments [PDF]. (2016, September 16). Washington, DC: US Department of Education. Retrieved from

<https://www2.ed.gov/policy/elsec/leg/essa/guidanceusesinvestment.pdf>

Chapter 3: Designing Knowledge Generation and Evaluation Plans

Introduction

When designing and managing an NSF S-STEM grant, it's essential to go beyond merely providing financial support to low-income, talented S-STEM Scholars. A well-rounded program must seek to understand its broader impacts and assess the overall effectiveness of its initiatives. This comprehensive approach is built upon two fundamental pillars: [Generation of Knowledge \(GoK\) \(or Knowledge Generation\) and Program Evaluation](#). While these concepts are interconnected, they serve distinct purposes and together form the foundation for assessing and improving NSF S-STEM programs.

Knowledge Generation

The core premise of an NSF S-STEM grant is its contribution to the broader fields of STEM education and workforce development through rigorous research studies. These studies should align with the [Common Guidelines for Education Research and Development](#) (IES, USDE, and NSF, 2013), which outline various research types, including foundational, early-stage exploratory, design and development, efficacy, effectiveness, and scale-up studies.

Types of Research

The table below summarizes the different types of research with an example related to NSF S-STEM grants.

Type of Research	Description	Example
Foundational Research	Builds fundamental knowledge about underlying principles and mechanisms.	Investigating how financial stress affects the academic performance of low-income STEM students.
Exploratory Research	Early-stage research that examines relationships or phenomena to generate hypotheses for further investigation.	Exploring the relationship between mentorship experiences and self-efficacy in low-income NSF S-STEM Scholars.

Design and Development Research	Focuses on creating and testing new interventions or models.	Designing a peer-mentoring program tailored to the needs of low-income NSF S-STEM Scholars and evaluating its implementation.
Efficacy Research	Tests whether an intervention works under controlled conditions.	Assessing the impact of a structured research experience on retention rates of NSF S-STEM Scholars at a single institution.
Effectiveness Research	Examines the impact of an intervention in real-world settings.	Analyzing how a multi-institutional career readiness program affects job placement rates for low-income NSF S-STEM Scholars.
Scale-Up Research	Investigates the scalability and adaptability of proven interventions across different contexts.	Studying the replication of a successful STEM bridge program across multiple community colleges.

Expectations by Track

The expectations for knowledge generation differ by track (**make sure you read the most recent NSF S-STEM solicitation**):

1. **Tracks 1 and 2:** Projects are expected to contribute to the field by disseminating findings from external evaluation work. For example, a Track 2 project might examine how supplemental instruction impacts the persistence of low-income, talented students in STEM disciplines.
2. **Track 3:** These projects face more stringent requirements. In addition to external evaluation, they must include a robust research component demonstrating the efficacy and scalability of interventions across consortium institutions. For instance, a Track 3 project might explore how integrated research experiences across multiple institutions improve low-income, talented S-STEM Scholars' persistence and career readiness in STEM fields.

Examples of Knowledge Generation

- **Example 1:** A Track 1 project investigates the role of financial aid counseling in reducing dropout rates among low-income, talented NSF S-STEM Scholars.

- **Example 2:** A Track 3 consortium studies the effectiveness of a virtual mentorship program in enhancing the career aspirations of low-income, talented NSF S-STEM Scholars.

Theoretical Foundations

Successful NSF S-STEM projects are built upon a robust foundation of well-established educational and social science theories. These frameworks guide program design, implementation, research, and evaluation, ensuring interventions are both evidence-based and impactful. By leveraging these theories, NSF S-STEM projects can effectively address the unique challenges low-income, talented scholars pursuing STEM education face.

1. **Social Cognitive Theory (Bandura)**

Social Cognitive Theory emphasizes the dynamic interplay between personal, behavioral, and environmental factors. This theory provides a lens to understand how students' learning is influenced by their social context. It is a vital framework for programs that foster collaborative learning environments, such as living-learning communities.

2. **Social Cognitive Career Theory (SCCT) (Lent, Brown, and Hackett)**

SCCT extends Bandura's work by examining how personal, contextual, and experiential factors shape career-related decisions. This theory is particularly relevant for S-STEM programs as they prepare students for the STEM workforce, addressing barriers such as self-doubt or limited access to professional networks.

3. **Sense of Belonging Theory (Tinto)**

The Sense of Belonging Theory highlights the importance of students' connection to their institution in fostering persistence and academic success. Programs that create inclusive and supportive environments—through mentorship, peer networks, or culturally responsive practices—can significantly enhance the retention of low-income scholars.

4. **Social Change Model of Leadership (Astin and Astin)**

The Social Change Model of Leadership provides a framework for evaluating how campus leadership roles and community engagement initiatives impact student engagement and academic success. By promoting leadership development, NSF S-STEM programs can

empower scholars to become change agents within their fields and communities.

5. **Self-Efficacy Theory (Bandura)**

Self-efficacy theory focuses on individuals' belief in their ability to succeed, emphasizing the importance of interventions that build confidence. For low-income, talented NSF S-STEM Scholars, targeted efforts to strengthen self-efficacy—such as skill-building workshops, personalized advising, and success coaching—can help overcome barriers to achievement in STEM fields.

By grounding their initiatives in these theories, NSF S-STEM programs can support the academic and career success of low-income, talented S-STEM scholars while also contributing to a deeper understanding of the factors that drive persistence and success in STEM education.

Reference List for Theories

1. Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Prentice Hall.
2. Lent, R. W., Brown, S. D., & Hackett, G. (1994). Toward a unifying social cognitive theory of career and academic interest, choice, and performance. *Journal of Vocational Behavior*, 45(1), 79-122.
3. Tinto, V. (1993). *Leaving College: Rethinking the Causes and Cures of Student Attrition*. University of Chicago Press.
4. Tinto, V. (2012). *Completing College: Rethinking Institutional Action*. University of Chicago Press.
5. Astin, A. W., & Astin, H. S. (1996). *A Social Change Model of Leadership Development: Guidebook*. Higher Education Research Institute.
6. Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. W.H. Freeman.

Research Questions (RQs)

Research Questions (RQs) are specific, focused inquiries that guide the direction of a research study. In the context of education or social science research, RQs are designed to generate knowledge that addresses issues, challenges, or gaps within the field. These questions are typically grounded in

existing research literature to ensure that the study builds upon or contributes to established knowledge. RQs must also be directly linked to the unique needs of the population being studied.

In the case of Scholar populations in consortia (Track 3), the RQs should reflect the specific characteristics, challenges, and needs of those students at the various institutions involved. By integrating both the broader academic context and the specific circumstances of the target population, RQs can help ensure that the research is relevant, impactful, and tailored to the real-world context of the students it aims to serve.

Some sample examples include:

1. *How do targeted mentoring programs influence the academic persistence of low-income, talented NSF S-STEM Scholars?*
2. *What impact does participation in undergraduate research experiences have on the career aspirations of low-income, talented NSF S-STEM Scholars?*
3. *How do supplemental instruction and cohort-based activities affect the retention and transfer rates of low-income, talented NSF-STEM community college Scholars?*
4. *What are the long-term effects of financial support and professional development activities on the workforce outcomes of low-income, talented NSF S-STEM Scholars?*
5. *How do participating in STEM-themed first-year experiences (FYE) and peer mentoring shape the NSF S-STEM Scholars' cognitive development, specifically their ability to apply evidence-based learning strategies and metacognitive skills in their STEM coursework?*
6. *How does participation in peer mentoring and tutoring affect the development of self-efficacy, resilience, and problem-solving skills among low-income, talented NSF S-STEM Scholars, and how do these skills translate to their academic performance and retention in STEM programs?*

Evaluation

Evaluation in the NSF S-STEM context is a systematic process of assessing the design, implementation, and outcomes of an NSF S-STEM program to determine its effectiveness, alignment with project goals, and overall efficacy of the program. Evaluation involves collecting and analyzing data to provide evidence of the program's impact on student success, institutional capacity, and broader STEM education objectives. Evaluation results inform continuous improvement,

demonstrate accountability, and contribute to the broader knowledge base in STEM education.

Evaluation Questions

Program-level evaluation questions are designed to assess the overarching effectiveness and impact of the NSF S-STEM initiative as a whole. These questions align with the program's goals and provide insights into its ability to address the unique needs of low-income, talented scholars.

Sample Program-Level Evaluation Questions

1. **Retention and Graduation:**

- *How does the program impact the retention and graduation rates of low-income S-STEM Scholars in STEM disciplines?*
- *Are there observable differences in retention rates among scholars based on demographic or institutional factors?*

2. **Academic Success:**

- *To what extent do program interventions, such as financial support and academic advising, enhance the academic performance of low-income scholars?*
- *How do scholars' participation in program activities (e.g., workshops, mentoring) correlate with academic outcomes like GPA and course completion rates?*

3. **Career and Workforce Readiness:**

- *How effectively does the program prepare low-income, talented NSF S-STEM Scholars for STEM workforce entry or advanced education opportunities?*
- *What proportion of NSF S-STEM Scholars secure STEM-related internships, jobs, or graduate school placements after program participation?*

4. **Equity and Access:**

- *What challenges do low-income scholars face in accessing program resources, and how effectively are these barriers addressed at the program level?*
- *Are program resources and opportunities equitably distributed among scholars from diverse backgrounds and institutions?*

5. **Scalability and Sustainability:**

- *To what extent are program practices scalable across different institutional contexts?*

- *What strategies have been implemented to ensure the long-term sustainability of the program’s interventions and impacts?*

6. Program Improvement and Adaptation:

- *What feedback do scholars and stakeholders provide about the program’s strengths and areas for improvement?*
- *How effectively does the program adapt to address emerging needs or challenges faced by low-income scholars?*

By focusing on these program-level questions, evaluation efforts can provide a comprehensive understanding of the NSF S-STEM program’s impact and guide continuous improvement to better serve low-income, talented scholars in STEM disciplines.

Differences Between Knowledge Generation and Program Evaluation

As stated above, all NSF S-STEM projects must integrate both **Knowledge Generation (GoK)** and **Program Evaluation** to ensure a comprehensive approach to advancing STEM education and supporting low-income, talented scholars. While these components share a common goal of enhancing program outcomes, they differ in purpose, scope, methods, audience, and outcomes.

Key Differences Between Knowledge Generation and Program Evaluation

Aspect	Knowledge Generation (GoK)	Program Evaluation
Purpose	Contribute to broader STEM education research.	Assess program effectiveness and guide continuous improvement.
Scope	Hypothesis-driven research with generalizable findings.	Focused on project-specific goals and outcomes.
Methods	Employs rigorous research methodologies (where feasible) (e.g., experimental designs) and data collection techniques.	Utilizes mixed methods tailored to program needs (e.g., surveys, focus groups).
Audience	Academic and research communities.	Program stakeholders, funders, and NSF.
Outcome	Publications, presentations, and theoretical advancements.	Actionable insights, program improvements, and stakeholder reports.

Explanation of Key Differences

1. **Purpose:**

- **Knowledge Generation (GoK)** focuses on advancing the broader understanding of STEM education by addressing research questions that contribute to the academic body of knowledge. For example, it may explore how mentorship impacts the persistence of low-income, talented NSF S-STEM students across different institutions.
- **Program Evaluation** assesses the specific program's success in meeting its stated objectives, such as improving retention rates or increasing STEM workforce readiness among scholars.

2. **Scope:**

- The GoK emphasizes generalizability, aiming to identify trends, practices, or interventions that can be applied across various contexts.
- Evaluation is localized, examining the fidelity of implementation and effectiveness of a particular program within its unique institutional and demographic context.

3. **Methods:**

- The GoK employs robust research methodologies, such as quasi-experimental designs and randomized controlled trials (albeit, rarely) or longitudinal studies, to ensure the reliability and validity of findings.
- Evaluation adopts a pragmatic approach, using mixed methods like pre/post surveys, academic performance data, observations, interviews, and focus groups to provide a holistic view of program implementation and overall performance.

4. **Audience:**

- The findings from the GoK are intended for researchers, educators, and policymakers who seek to understand and apply best practices in STEM education.
- Evaluation results are directed toward program staff, funders, and participants, offering insights for immediate application and improvement.

5. **Outcome:**

- The GoK outcomes are typically disseminated through academic publications, conference presentations, and contributions to theoretical frameworks, enhancing the field of STEM education.

- Evaluation outcomes focus on actionable recommendations, such as refining mentoring strategies or addressing barriers to resource access, to improve program delivery and impact.

Examples Illustrating the Distinction

1. **Knowledge Generation Example:**

A Track 3 NSF S-STEM project might investigate the efficacy and scalability of peer mentoring programs across consortium institutions, producing findings that inform national best practices in mentoring low-income STEM students.

2. **Program Evaluation Example:**

The same project could evaluate whether its peer mentoring program improves academic outcomes for participating scholars at one institution, using retention and GPA data to refine the program locally.

3. **Combined Approach Example:**

A project could conduct **Knowledge Generation (GoK)** by researching how professional development workshops impact the career readiness and self-efficacy of low-income NSF S-STEM Scholars across multiple institutions. Simultaneously, the project could carry out **Program Evaluation** by assessing the effectiveness of workshop implementation at each site, focusing on participation rates, logistical challenges, and scholar satisfaction.

The combined approach ties the broader research goal (impact of workshops on career readiness) with the practical evaluation need (implementation and operational success), ensuring alignment with typical NSF S-STEM activities. It also highlights how GoK findings inform the field while evaluation provides actionable feedback for program improvement.

By integrating GoK and Program Evaluation, NSF S-STEM projects ensure both a contribution to the field of STEM education and continuous improvement of their specific initiatives. This dual approach enables programs to meet the immediate needs of scholars while also informing broader educational practices.

Conclusion

The success of an NSF S-STEM program hinges on the integration of knowledge generation and program evaluation. By embracing this comprehensive approach, program teams can create sustainable, impactful initiatives that empower low-income, talented Scholars and contribute meaningfully to the STEM workforce pipeline.

Resources for Further Reading

1. NSF S-STEM Program Solicitation: [NSF Website] (<https://www.nsf.gov>)
2. Kirkpatrick's Four Levels of Training Evaluation: [Kirkpatrick Partners] (<https://www.kirkpatrickpartners.com>)
3. Handbook on Qualitative Research Methods in Education: [SAGE publications] (<https://www.sagepub.com>)
4. Patton, M. Q. (2015). *Qualitative Research & Evaluation Methods: Integrating Theory and Practice*. SAGE Publications.

References

Books by Bandura:

1. Bandura, A. (1986). *Social Foundations of Thought and Action: A Social Cognitive Theory*. Prentice Hall.
This foundational book outlines the core principles of Social Cognitive Theory, including self-efficacy, observational learning, and the interplay between personal, behavioral, and environmental factors.
2. Bandura, A. (1997). *Self-Efficacy: The Exercise of Control*. W. H. Freeman.
This book delves deeper into the concept of self-efficacy, a central element of Social Cognitive Theory, and its applications in various domains.

Key Articles by Bandura:

1. Bandura, A. (1977). Self-efficacy: Toward a unifying theory of behavioral change. *Psychological Review*, 84(2), 191–215. <https://doi.org/10.1037/0033-295X.84.2.191>

This article introduces the concept of self-efficacy and its role in behavioral change, a cornerstone of Social Cognitive Theory.

2. Bandura, A. (2001). Social cognitive theory: An agentic perspective. *Annual Review of Psychology*, 52(1), 1–26. <https://doi.org/10.1146/annurev.psych.52.1.1>

This article provides a comprehensive overview of Social Cognitive Theory, emphasizing human agency and the dynamic interaction between personal, environmental, and behavioral factors.

Secondary Sources and Applications:

1. Pajares, F. (2002). Overview of social cognitive theory and self-efficacy. Retrieved from <https://www.uky.edu/~eushe2/Pajares/eff.html>

This resource provides a concise summary of Social Cognitive Theory and its applications in education and other fields.

2. Schunk, D. H., & DiBenedetto, M. K. (2020). Social cognitive theory, self-efficacy, and student learning. *The Oxford Handbook of Human Motivation*, 2nd ed., Oxford University Press. <https://doi.org/10.1093/oxfordhb/9780190666453.013.2>

This chapter discusses the relevance of Social Cognitive Theory in educational contexts, with a focus on self-efficacy and motivation.

Chapter 4: Developing and Using a Logic Model or Theory of Change

When developing an NSF S-STEM proposal or evaluation plan, you'll encounter the terms *Logic Model* and *Theory of Change* (TOC). Both are critical tools for articulating your program's design and evaluation. Understanding their purposes can help you meet the grant's requirements for clearly defined objectives, outcomes, and impact. So, let's dive into the fascinating world of **logic models**.

Logic Models are visual tools, or diagrams, which act as a blueprint for your programs, projects, or interventions. They outline the connections between key components and show how resources, activities, outputs, and outcomes interact to achieve the goals of your initiative. In simpler terms, *a logic model is like a treasure map—guiding you through the twists and turns of your program with a clear, structured plan.*

Check out the 2025 webinar on **Developing a Logic Model and Theory of Change for your S-STEM Grants** [here](#).

Why is the Logic Model Important?

You might be asking, "Why do I need a logic model?" Well, for one, it's required! More importantly, it helps you articulate the **big picture** of your NSF S-STEM program. Here's why it matters:

1. **Clarifying Your Path:** Logic models give a clear visual representation of your program's flow, helping stakeholders understand how the resources (inputs) lead to activities, which then produce outputs and eventually achieve long-term outcomes.
2. **Tracking Progress:** Logic models help evaluators track the progress of a program, identify areas for improvement, and make necessary adjustments along the way. They can be invaluable in ensuring that your goals are met as you execute the program.
3. **Streamlining Communication:** Think of a logic model as a visual elevator pitch for your project. It's a quick, effective way to explain what your program is about, what it aims to achieve, and how it will get there.

4. **Aligning Proposal Components:** When writing a grant or project proposal, it's essential to ensure your logic model aligns with other components, such as:

- Your program's goals and objectives
- Your project management plan
- Organizational chart or scope of work
- The budget

These parts should work in harmony, like puzzle pieces fitting together.

Breaking Down the Parts of a Logic Model

A typical logic model has several key components. Let's take a closer look:

1. Inputs/Resources

These are the essential resources invested in the program, such as:

- Funding
- Staff
- Equipment
- Materials

Think of these as the fuel that powers your program.

2. Activities/Processes

What actions will your program undertake? These are the **specific tasks or interventions** that will be carried out, like:

- Workshops
- Training sessions
- Services provided

This is where your program's work comes to life.

3. Outputs

These are the **immediate products** of the activities. Outputs are tangible, measurable things, such as:

- Number of workshops conducted
- Participants reached
- Materials distributed

Outputs are what you can count and report.

4. Outcomes

Outcomes are the **changes or benefits** that happen because of your activities and outputs. These are categorized into:

- **Short-term outcomes:** Quick wins or immediate changes (e.g., increased knowledge after a workshop).
- **Intermediate outcomes:** Changes that take time, such as a change in behavior or skill development.
- **Long-term outcomes:** The ultimate goal of your program, such as increased career opportunities or improved community health.

Assumptions and External Factors

A logic model doesn't just lay out what happens—it also reflects the **assumptions** and **external factors** that can influence outcomes. These assumptions are beliefs about how the program will work and what you expect from the participants, resources, or environment.

For example, assumptions might include:

- The participants will engage in the program as expected.
- Resources will be available throughout the program.
- External factors (like policy changes or economic shifts) will remain stable.

These assumptions need to be **validated** through research and experience to ensure that they are realistic and well-founded.

Why is a Theory of Change Important

- **Theory of Change (TOC):**
A Theory of Change dives deeper, addressing the “why” behind the program’s design. For

NSF S-STEM, a TOC explains the potential causal institutional mechanisms and perceived assumptions that connect your program's activities to its desired outcomes. It incorporates contextual factors like institutional challenges, the needs of low-income and underrepresented students, and the external factors influencing success.

Key Features for NSF S-STEM TOCs:

- **Causal Pathways:** Explains how scholarships combined with mentoring and support services lead to improved student success in STEM.
- **Assumptions:** Highlights critical factors, such as the assumption that financial support reduces work hours, enabling students to focus on academics.
- **Contextual Factors:** Addresses barriers faced by low-income students, such as lack of access to STEM role models or career networks.
- **Evidence Base:** Incorporates research on effective practices in student retention, STEM education, and workforce preparation.

TOCs are especially valuable in addressing NSF's interest in understanding how your program contributes to systemic change and broader impacts.

Differences between a Logic Model and TOC

For NSF S-STEM, a Logic Model provides a structured way to present the operational steps of your program, making it easier for reviewers to see the program's feasibility and measurable outcomes. A Theory of Change, on the other hand, articulates the rationale and evidence supporting your program's design, ensuring reviewers understand the broader context and long-term goals.

The table below provides an example of how to map out how each component of a logic model interconnects, and the assumptions about the program and its participants. You can expand this matrix based on your program's specific components and goals.

Component	Definition	Example	Measurement/Indicator	Assumptions
Inputs/ Resources	The resources that are invested in the program include funding, staff, and materials.	Funding for the program- NSF, skilled staff, equipment, and technology.	Amount of funding, number of staff, availability of resources/materials.	Resources are adequate and timely for program execution. Institutional policies and practices are in place and adequate
Activities/ Processes	The specific actions or processes carried out as part of the program. These are the interventions or services provided.	Workshops, seminars, training sessions, mentorship, industry visits, webinars, and other programs.	Number of sessions conducted, number of participants per session.	Participants will engage with the activities and apply what they learn.
Outputs	The immediate, tangible products or results of the activities. These are quantifiable.	100 workshops were conducted, 300 materials were distributed, and 200 students attended.	Number of workshops held, number of materials distributed, attendance.	The activities are implemented as planned and reach the intended audience.
Outcomes	The changes or benefits that occur as a result of the outputs and activities.	Short-term: Increased awareness, Intermediate: Increased skills or knowledge Long-term: Improved completion, job outcomes, or better health.	Surveys, pre/post-test results, job placement rates.	Participants will benefit from the program in the short, medium, and long terms.

When to Use a Logic Model or a TOC

- Use a **Logic Model** in your proposal to present a clear, concise depiction of how your program activities will lead to intended outcomes, aligning with NSF's focus on measurable results.
- Use a **Theory of Change** in your proposal narrative or evaluation plan to explain the underlying rationale for your program's approach, addressing NSF's emphasis on systemic change and broader impacts.

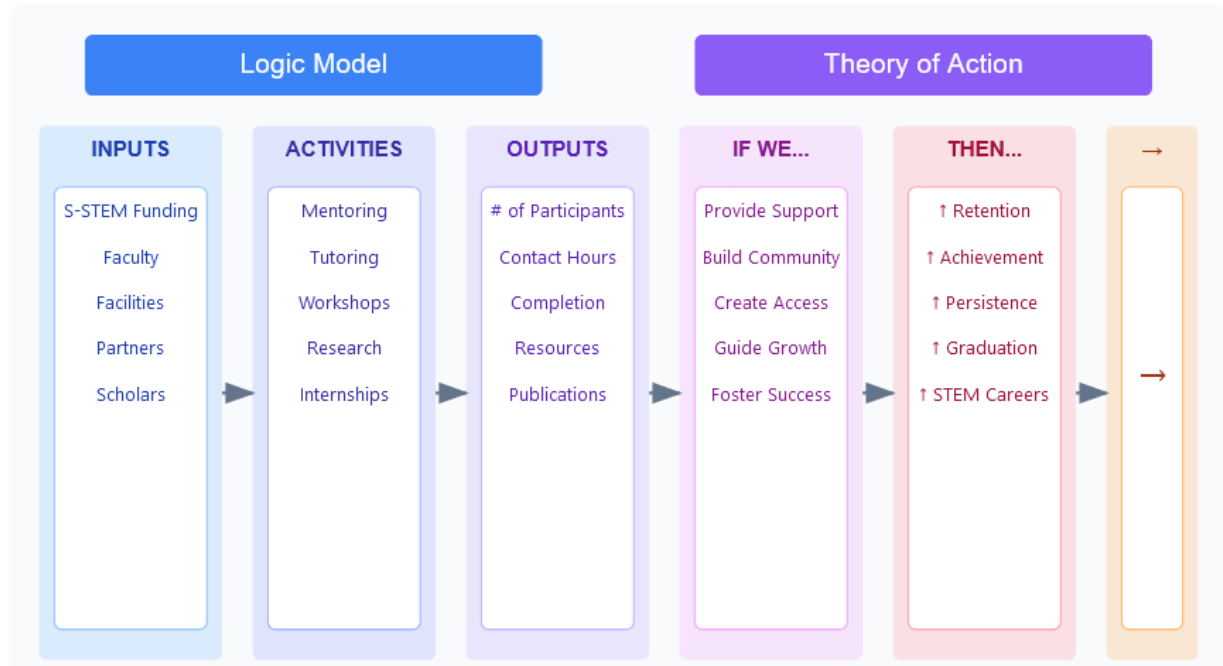
Example for the NSF S-STEM

- **Logic Model:** Scholarships → Mentoring → Increased retention and graduation rates → Diversified STEM workforce.
- **Theory of Change:** By reducing financial burdens through scholarships and providing mentoring, low-income students will have the time and support needed to succeed academically, ultimately contributing to a more diverse and skilled STEM workforce. This assumes that institutional support and faculty engagement are consistent and that students have access to additional resources like internships and career guidance.

In short, while a logic model describes the steps, a theory of change explains the why behind those steps.

Combining the Two: A Comprehensive Approach

Sometimes, the best approach is to combine **both** the logic model and the theory of change. This allows you to show **what** will happen and **why** it will happen, all while addressing the **context** in which the program operates. This integrated approach is especially useful in **complex programs**, where multiple factors come into play. **It may look something like this:**



Challenges with Logic Models

While logic models are powerful tools, they are not without their quirks. Let's explore some common challenges:

1. Oversimplification

Logic models often portray a **linear cause-and-effect** relationship that doesn't always reflect the messy reality of how programs unfold. In real life, outcomes may not always be directly tied to activities in such a neat, cause-effect way.

2. Static Nature

Once created, logic models can sometimes become **outdated**. Programs evolve, and so should the logic model. To keep it useful, make sure to **update** your logic model regularly as the program progresses and new insights arise.

3. Unintended Outcomes

Most logic models focus on **intended outcomes**, but what about those unexpected results—good or bad—that crop up along the way? Be mindful of these and consider ways to **capture** and evaluate them as part of your program.

4. Misalignment Between Outputs and Outcomes

Sometimes, the **outputs** don't accurately reflect the true **outcomes**. For example, **attendance** might be an output, but it doesn't necessarily indicate whether the program led to any change in knowledge or behavior. When planning your logic model, be careful to ensure that your outputs truly align with the outcomes you're aiming for both in the short and long term.

Practical Tips for Logic Models

Here are a few tips for creating more effective logic models:

1. **Stay Realistic:** Be honest about the assumptions you're making and the external factors that might affect your program. Recognize that not everything will go according to plan.
2. **Incorporate Feedback:** Get input from stakeholders at every stage. Their perspectives can help ensure your logic model reflects the full complexity of your program.
3. **Use Visuals Wisely:** A well-designed **visual logic model** can be a powerful tool to convey complex information quickly and clearly. Use color coding, shapes, and arrows to highlight relationships between inputs, activities, outputs, and outcomes.

Conclusion

Logic models (LM) and theories of change (TOC) are invaluable tools that provide a clear and structured framework for understanding how a program's activities lead to desired outcomes. While a logic model offers a visual roadmap of inputs, activities, outputs, and outcomes, a theory of change delves deeper into the underlying assumptions and pathways driving those changes. Together, they help articulate the program's purpose, ensure alignment with goals, and facilitate evaluation, making them essential for planning, implementation, and continuous improvement.

By clearly mapping out how a program will operate, what it will produce, and what outcomes it seeks to achieve, you can ensure that your program is structured for success. So, whether you are working on a small community project or a large-scale initiative, consider your logic model as the roadmap that will guide you toward your goals.

Let's keep things **dynamic**—just as programs evolve, so too should your logic models. They are not set in stone but should be flexible and responsive to the changing landscape of your work.

Useful Resources

W.K. Kellogg Foundation Logic Model Development Guide. Available here:

<https://nj.gov/state/assets/pdf/ofbi/kellogg-foundation-logic-model-development-guide.pdf>

Worksheet: <https://evalu-ate.org/wp-content/uploads/2023/12/Logic-Model-Template.pdf>