Project STEP-UP

STEM Trends in Enrollment and Persistence for Underrepresented Populations

Linking Theory to Practice

Understanding Theoretical Underpinnings of STEM Intervention Programs At Large, Public, Research Universities

Introduction

The process of enhancing Science, Technology, Engineering, and Mathematics (STEM) education to increase student participation in STEM majors and careers is receiving considerable attention from national policymakers (Leggon & Pearson, 2008; Valla & Williams, 2012). Despite the increased access to STEM opportunities, research suggest that the proportion of students from underrepresented racial/ethnic populations (e.g. African American, Latino, and American Indians/Alaskan Natives) in STEM major and career fields remains low (Strayhorn, 2009, 2010). There are some positive trends in STEM educational attainment, most notably the role of Minority Serving Institutions (MSIs) in producing a steady number of students of color with STEM degrees (Whittaker & Montgomery, 2012). However, increasing STEM participation among underrepresented students at Predominantly White Institutions (PWIs), particularly public research universities, remains a significant challenge.

There is an ongoing movement to develop programs and institutional practices geared towards enhancing the access, persistence, and completion rates in STEM fields of underrepresented students at large, research public universities. Insight into the theory and logic that supports the development of STEM intervention programs at these institutions, in addition to institutional practices, provide key information with respect to how to best recruit, retain and support traditionally underrepresented students in STEM programs and occupations. The purpose of this brief is to examine the use of theory and logic models in the development of STEM Intervention Programs (SIPs).

Program Evaluation: Logic Models

In general, logic models are traditionally utilized within the field of evaluation research in order to describe and evaluate a given outreach program to determine the effectiveness of the program (Renger & Titcomb, 2002; Kaplan & Garrett, 2004). While logic models are typically employed to measure outcomes of educational programs, they also permit "program managers and evaluators to see more clearly the underlying rationale or logic of a program" (Chen, Cato, & Rainford, 1998-1999, p. 450). Although not explicitly addressed in program evaluation literature, at the core of logic models, is the theory behind the model development. The theory essentially drives the creation of action items that results in the birth of a program that is structured to address a larger problem either programmatically with an already established outreach program or in response to a macro or micro problem or concern. This brief focuses on examining the use of theory and the creation of logic models for STEM intervention programs at large, research, public universities.

Key Themes

The analysis of the interview data revealed three main themes: 1) Informal theory and logic behind the development of STEM Intervention Programs, 2) Formal theory and logic behind the development of STEM Intervention Programs and 3) Institutional hierarchy of the theory and logic behind the development of STEM Intervention Programs.

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Informal Theory and Logic behind the Development of STEM Intervention Programs

Informal development of STEM intervention program suggests there is no theoretical underpinning or logic to program development. As a particular STEM intervention program lacks theoretical research to supports its creation, the program is not directly tied to a larger course of action or societal concern. Consequently, not having a STEM intervention program grounded in theory or research results in programmatic practices that are unorganized and a foundation that is deficient in meeting the needs of a targeted population. One STEM intervention program administrator stated:

> "I guess we pretty much mimicked [foundation] program, because we don't know what they're doing—what type of magic they have—but they have no problem getting women to apply and attend. We're like, "We're doing the same stuff, but we're lacking somewhere." And I won't say that on tape, but we're lacking somewhere, obviously, because we can't pull numbers like them. And we started off doing similar to them, going out where the students are, opposed to them coming to us. Let's go to them. We even offered pizza. We go during their lunch hours, that way we won't interrupt classes. We try and we're still trying. We have new ideas for the upcoming years, but a few of us won't be around, so we're like, "Okay now what's gonna happen?" But I'm sure that question is coming up soon in the future"

Not focusing on research that can inform recruitment strategies that is program specific to the STEM intervention program resulted in the implementation of practices based on strategies of another program that did not yield the desired results. Thus revealing a STEM intervention program not centered on theory and resulting in the implementation of practices that are not responsive to the population it intends to serve.

Formal Theory and Logic behind the Development of STEM Intervention Programs

Formal development of STEM intervention programs suggests there is sound research and data that drives the creation of STEM intervention programs. Program managers and administrators reference research and/or program observations that guide the implementation of programmatic practices that are employed to recruit, retain and support students in their quest for postsecondary educational attainment in a STEM major field or career in order to uphold the intended theoretical underpinnings of the STEM intervention program. For instance, one STEM intervention program coordinator said, "This is kind of our strategic plan, and it sort of takes these—and we've actually got things that are action items in each one of those areas that are part of the program. It's research based…"

The abovementioned quote reveals that some STEM program administrators actively seek out and utilize research and theory to inform the implementation of programmatic practices in their respective programs. The same STEM intervention program administrator also states, "So, if it doesn't

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work—it's too soon to tell, but if it doesn't work, then they're wrong. I'm trying to take a very comprehensive approach, that according to research and the literature is supposed to work—that nobody is really doing that. This is how I see us being able to eventually be an exemplar." Thus, this administrator reveals how research is utilized as an evaluation tool to assess whether programmatic practices that are implemented based on research suggestions is helping STEM intervention program administrators meet the outlined mission and goals of their STEM intervention programs.

Institutional Hierarchy of STEM Intervention Program Theory and Logic

Sometimes the theory and development of STEM intervention programs is situated within the hierarchy of an institutional, departmental and/or organizational structure at large, research, public universities; more specifically, the theory and logic of the development of the SIP is tied to the theory grounded in respective departments at a given institution or organization. Therefore, any changes in the theory and logic can very much be a result of changes in the institutional, departmental and/or organizational culture or the value of the administration at a given point in time. Although a shift in theoretical underpinnings could be positive, meaning program staff, organizations and institutions are up to date on a larger societal need and are working to fill the void, a shift in theoretical underpinnings could also mean a loss in a cause that is equally important. For example, one STEM intervention program administrator discussed a shift in theoretical underpinnings that resulted in a loss of funding for student precollege programs. The administrator stated:

> "Now we're no longer going to be funding the student precollege programs because NASA wants us to focus on only teacher training. They said let the education office, the precollege education office of the NASA education director, their main focus should be on 17 and younger, not yours, because we are a higher education program, so if you're going to spend your money, spend it on training teachers"

This kind of dramatic theoretical program shift changed the mission, goal and programmatic practices of a particular STEM intervention program that resulted in one theoretical transition for another. While the STEM intervention program administrator did not explicitly mention any negative consequences that resulted from the theoretical shift, one could assume that the transition in funding, authority, and program service delivery caused some disruption. In particular, one population was left to deal with the challenges of a new administration and shift in funding that possibly impacted the way in which services were delivered, therefore resulting in changes that may not support the original intended program mission and goals of the STEM intervention program.

Implementation for Policy and Practice

This brief presents useful findings for future implementation of policy and practices that address the following question: How can program administrators at large, research, public universities, develop a sound theoretical foundation and logic model for their respective STEM intervention programs in order to ensure meeting their established mission and goals and intended outcomes? For program administrators that are seeking to understand ways to incorporate theory into their day-to-day practices, developing a sound theoretical base prior to the implementation of the STEM

intervention program to ensure practices are developed that enable the program to meet its mission and goals is key.

For program administrators that currently utilize research and sound theory to inform the logic model of their STEM intervention programs, it could be useful to collaborate with faculty members at their institution to develop workshops that help program administrators better understand the current outcomes of their STEM intervention programs and to ensure they remain grounded in the theoretical foundation upon which they were built. Utilizing program evaluation to determine whether STEM intervention programs are meeting their outlined mission and targeted goals is also important and necessary.

Finally, for program administrators that must adhere to theoretical developments that are driven by external institutional structures or organizations, it is imperative to schedule meetings with key point of contacts within that organization to gain a better understanding of program development from an institutional, departmental and/or organization standpoint. A larger suggested policy implementation would be to require all STEM intervention programs to have a theoretical foundation and logic model followed by a program evaluation. This will ensure all programs are structured to address a larger need and that STEM intervention programs are implementing practices that produce intended outcomes that are aligned with the theoretical foundation of the programs.

Conclusion

This short summary provides insight into the theoretical foundation of STEM intervention programs that are structured to enhance diversity in STEM major fields and the STEM workforce. Educational opportunities and programs employed to increase the numbers of underrepresented students who enroll, persist, and complete degrees in STEM related fields is one of many issues at the forefront of education reform. The development of STEM intervention programs take time and is a comprehensive process that involves identifying a larger problem and structuring programmatic efforts in order to improve access and retention in STEM for all students. Recall logic modeling permits "program managers and evaluators to see more clearly the underlying rationale or logic of a program" (Chen, Cato, & Rainford, 1998–1999, p. 450). Examining STEM intervention programs, particularly the theory that guide their development, serves as a lens to understand ways in which theory and practice can be merged to ensure services and supports are in place for students as they progress through challenging classes and programs that are often structured to weed out students (Foor and Walden, 2009) rather than serving as mechanisms to retain them.

The absence of theory and research as a part of a STEM intervention program's grounding can result in a loss of programmatic services that ensure students are receiving the support needed to navigate and succeed in their respective STEM field. Research and theory guide organizational development and services that are structured to enhance student academic success. STEM intervention programs are key to providing access to services that are essential to student progress in STEM related fields. Therefore, as long as the larger movement to increase the number of underrepresented students in STEM major fields and careers continues to grow, it remains critical to have programs grounded by a theoretical foundation to ensure services are provided in a such a way that helps students' academic progress rather than hinders their success.

References

Chen, W. W., Cato, B. M., & Rainford, N. (1999). Using a logic model to plan and evaluate a community intervention program: a case study. International Quarterly of Community Health Education, 18(4),449-458.

Foor, C. E., & Walden, S. E. (2009). "Imaginary Engineering" or" Re-imagined Engineering": Negotiating Gendered Identities in the Borderland of a College of Engineering. NWSA Journal, 21(2), 41-64.

Kaplan, S. A., & Garrett, K. E. (20OS). The use of logic models by community-based initiatives. Evaluation and Program P1anrring, 28(2), 167-172.

Leggon, C. B., & Pearson, W. (2008). Assessing programs to improve minority participation in STEM fields: What we know and what we need to know. Cornell University Press, Ithaca, NY.

Renger, R., & Titcomb, A. (2002). A three-step approach to teaching logic models. American Journal of Evaluation, 23, 493-504.

Strayhorn, T. L. (2009, October). Work in progress-academic and social barriers to Black and Latino male collegians in engineering. In Frontiers in Education Conference, 2009. FIE'09. 39th IEEE (pp. 1-3). IEEE.

Strayhorn, T. L. (2010, October). Work in progress-Social baerlers and supporls to underrepresented minorities' sucoess in STEM fields. In Frontiers in Education Conference (FIE), 2010 IEEE (pp. SIH-l). IEEE.

U.S. Census Bureau (2010): Population by Hispanic or Latino Origin and by Race for the United States: 2000 and 2010.

Valla, J. M., & Williams, W. M. (2012). Increasing Achievement and Higher-Education Representation of under-Represented Groups in Science, Technology, Engineering, and Mathematics Fields: A Review of Current K-12 Intervention Programs. Jouma1 of women and minorities in science and engineering, 18(1).

Whittaker, J. A., & Montgomery, B. L. (2012). Cultivating Diversity and Competency in STEM: Challenges and Remedies for Removing Virtual Baerlers to Constructing Diverse Higher Education Communities of Sucoess. Journal of Undergraduate Neuroscience Education, 11(1), A44.

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