Understanding the Organizational Structure of STEM: Intervention Programs Impact on Service Delivery

Montrischa M. Williams
University of Illinois of Urbana-Champaign

Abstract

This study examines the extent to which the organizational structure of STEM intervention programs impact the way services are delivered to underrepresented students in STEM fields. This study utilizes data gathered in 2009 and 2010 through semi-constructed interviews with 55 program administrators at ten universities. Participants were asked questions regarding the history, goals, services, and outcomes of the program, as well as how the program is structured and funded. Findings reveal that two types of structures, specifically physical/visible and organizational play a critical role in how services are delivered to students. The physicality and visibility of where the program is located on campus serves as a strategic tool to ensure students have easy access to program services or creates issues of access to STEM opportunities and services. Additionally the organizational structure, particularly the organization of the entity (i.e. who reports to whom, and how various aspects of services are delivered to students) impacts how services are delivered. These findings have significant implications considering the recent trend to increase access to underrepresented students in STEM fields and careers. Recommendations such as creating strategic marketing plans, centralizing program services, and re-locating STEM intervention programs offered.

Keywords: STEM, Student Support, Best Practices, Access

Introduction

In recent years, the United States have put forth effort to prepare and increase the number of underrepresented students in Science, Technology, Engineering, Mathematics (STEM) fields. This effort has incited renovation in pedagogical as well as institutional practices and educational programs that are geared towards engaging students earlier on in STEM fields; in addition to increasing postsecondary enrollment, persistence, and graduation rates for this student population. This exertion is more important now considering the United States is becoming more diverse. Particularly, recent trends show that by 2050 the minority population will account for half of the U.S. population (U.S. Census Bureau, 2010). Moreover the increasing global competition in science-related fields suggest that the United States must depend on current national students to fulfill the need of the skill-labored workforce in science related fields. Therefore emphasis on increasing the number of underrepresented students in science fields will continue to be of great importance.

There are a variety of STEM intervention programs. Resulting in educational opportunities for all students across the educational spectrum. Through STEM intervention programs, students are introduced to science fields, in which they were traditionally unaware, or engage in hands on experiences to bring an abstract thought of STEM to reality. These experiences can be complimented by services that include but are not limited to tutoring, mentoring, research, and financial support. Some programs also utilize this experience to create a pipeline from high school to college, college to graduate school or pipeline to the workforce in STEM areas. Whichever the case may be, the programs are designed to respond to the national call of increasing the number of underrepresented students in STEM related major fields and careers.

Despite the influx in educational opportunities that are designed to provide exposure and experience in STEM related fields for underrepresented students, inherent differences in the structure of STEM intervention programs may essentially alter and impact how services are provided and delivered. To this end the structure of STEM intervention programs can create issues of access to STEM educational opportunities. This paper investigates the organizational structure of STEM intervention programs at large, research, public universities. Examining STEM intervention programs as organizational entities allows the broader audience to better understand how organizational structure may impact service delivery.

Review of Relevant Literature

Organizational Structure

The examination of organizational structure is not a new phenomenon. Through notable scholars (ex. Blau, 1965, Hage, & Aiken, 1969, 1970, and Hall, 1963) we are able to critically assess theories of organizational structure in practice. As a result, we are better able to understand intricacies of organizational structures and its' effectiveness. There are various ways to define organizational structure, however in general, "Organizational structure is the way responsibility and power are allocated, and work procedures are carried out, among organizational members"(Nahm, Vonderembse & Kouftero, 2002, p. 283). This definition of organizational structure is vague enough to transcend into various fields of study. Further this definition gives researchers the ability to not only define the type of organizational structure in a given context, but also provides space for organizational structures to be examined from various methodological perspectives.

Abraham Nahm, Mark Vonderembse and Xenophon Kouftero (2002) sought to develop a comprehensive framework to better understand relationships between structural dimensions. The development of this framework included outlined sub-dimensions of organizational structures. The authors utilized responses of manufacturing firms to test structural

relationships. The sub-dimensions include: nature of formalization, number of layers in a hierarchy, level of horizontal integration, locus of decision making, and level of communication (Nahm et al. 2002). The authors found that the relationships between sub-dimensions, particularly nature of formalization, number of layers in hierarchy, and level of horizontal integration, impacts communication, decision-making, and day-to-day practices in manufacturing firms. Although Nahm et al. (2002) primarily based their analysis on manufacturing firms, the relationship amongst the sub-dimensions and organizational structures in general is prevalent in literature and transcends to other fields of study. For instance, we can examine how those same relationships may or may not impact day-to-day operations in institutions of higher education and educational programs.

Joseph Berger (2002) examined the structures of college and universities and its impact on college student learning. Like other notable scholars (ex. Tinto, 1993 and Hurtado, Milem, Pedersen-Clayton, & Allen, 1998), Berger (2002) argues that the organizational structure of higher education and environment impacts student learning and overall experience. Considering that structures in higher education have significant impact on student learning, Berger (2002) suggest increased analysis of how institutions operate will assist working professionals in employing practices that are conducive to enhancing student college experiences. Furthermore, although Berger's (2002) findings give insight on relationships between "organizational structure at colleges and learning outcomes, it has provided little information about how one affects the other" (p. 55). Thus lending way into another component of organizational structure that is also central to this study, organizational effectiveness.

Organizational Effectiveness

Traditional examination of organizational effectiveness is aligned with understanding the goals of organizations and whether or not those goals were met. According to Arthur Bedeian (1986) when using the goal approach to understanding organizational effectiveness, organizations are more "concerned with the attainment end products and goals such as productivity, net profit, and growth" (p. 186). Additionally Bedeian (1986) suggests organizations use system resource model, and multiple constituency approach to assess organizational effectiveness. Interestingly, regardless of what theoretical approach is employed, Bedeian (1986) articulates, organizational effectiveness remains understudied. This is in part due to differences in goal attainment within various organizational contexts. To this end, there are multiple ways to examine organizational effectiveness. Incorporating this brief review of organizational effectiveness is important to this study for a few important reasons. One if the organizational structure of an organization (particularly STEM intervention programs) is poorly structured, then it may be impossible to determine if the organization is effective in meeting its outlined goals. Second, introducing organizational effectiveness will allow the broader audience to begin critically thinking about what aspects of organizational structures work or not work in meeting goals. By doing such, organizations particularly STEM intervention programs can engage in applying lean processes that essentially eliminate practices that "are wasteful, unnecessary, or may even prevent them from doing their job" (Ziskovsky & Ziskovsky, 2007, p. 6). Thus improving day-to-day operations that can positively impact how services are delivered to students.

This study utilizes both organizational structure and organizational effectiveness as a theoretical framework to understand how the organizational structure of STEM intervention program impacts service delivery. As part of the semi-structured interviews, program administrators were specifically asked about the physical location of their STEM intervention program in relation to their department or respective university. The physical location of where a STEM intervention program is located is simple to understand, however where the

STEM intervention program is housed organizationally is more complex. By examining the location of the organizational entity, we can better understand the effectiveness of the STEM intervention programs.

Data and Methodology

This study is part of a larger project that examines the enrollment, persistence, and graduation of underrepresented undergraduate students in STEM fields at large, public, research-intensive universities. The project employs both quantitative and qualitative methodology. The qualitative portion in which is the central methodological approach for this study, is particularly designed to gain an understanding of how STEM intervention programs are designed, how they operate, and how they serve their respective targeted student population. To recruit potential participants, research assistants broadly searched each of the ten universities website for STEM intervention programs that were structured to increase the enrollment, persistence, retention, and graduation of underrepresented students in science related fields. This resulted in 137 potential participants. All potential participants were sent an email initiation to be part of the study. Out of the 137 potential participants, 55 agreed to participate in the study. The 55 participants include program directors, administrators, faculty and staff of STEM Intervention Programs. The data were gathered in 2009 and 2010 through face-to-face semi-constructed interviews with 55 participants at ten universities.

Participants provided dates and times in which they were available to conduct the semi-structured interview. One Principal Investigator or Co Principal Investigator and research assistant interviewed interviewees. Participants were given a copy of their consent form. The semi-structured interviews lasted an hour. The demographic breakdown of the 55 participants are as follow: 12 male, 43 female, 26 Caucasian, 21 African American, five Latino, two Asian American, and one Native American. Twenty of the participants received their PhD, five were enrolled in a PhD program, 21 received their Master's degrees, and lastly, three had received their Bachelor's degrees. Prior to engaging in the interview, the Principal Investigator and research assistant built rapport with the participant by providing information related to their background and involvement in the project.

Participants were asked questions regarding the history, goals, services, and outcomes of the program, as well as how the program is structured and funded. For this study, particular attention is given to the following questions regarding the organizational structure of STEM intervention programs: 1.) Where in the administrative structure of the college or campus is the program located? Has it always been located there? And 2.) How might the organization of the department or college impact service delivery? Interviews were transcribed verbatim and coded for common themes found in thematic analysis that is used for "identifying, analyzing and reporting patterns (themes) within data" (Braun & Clarke, 2006, p. 79).

Results

Physicality of STEM Intervention Program

Findings in regards to the physical location of STEM intervention administrative structure reveal that students may have a difficult time gaining access to program services if the location of the STEM intervention program is distant from campus. The universities included in this study are large institutions. Departments, centers and student services may not be placed in a location that is accessible to all students. The following quotes explain how students as well as parents were concerned with the physical location of the program. Additionally one of the following quotes also exemplifies what happens when reporting structures results in lack of physical location of STEM intervention programs:

"The biggest question I always get from students and parents as I do recruiting in the spring, is why are you not in [department], somewhere closer? That may hurt us, but to have a program in an academic side that does support us so strongly, does help get women here, and the distance is hardly an issue."

"Nobody really knows the answer to that question. Okay so on paper and then the kind of day-to-day are very different. On paper, we report to the University College, which is sort of the ghost 12th college at the [university], and it captures any academic enrichment program that doesn't really have a home."

In contrast, there are instances where the location of the STEM intervention administrative structure and/or or services are praised by program administrators because the location of their program and services are easily accessible to students with no problem. This is in part due to the location being in a central building on campus. The following quotes by participants shows how centralizing program services provides for better opportunities to engage the targeted student population for their respective STEM intervention program:

"This is a fabulous office.. I mean this is the hub of the college..So women come in here constantly to find me. So it's a great location. The only negative thing that I have about it is that obviously, people come in for other reasons and if I'm the only one here or I'm the first office they see, they come and ask me a lot of questions I can't answer because I don't do what these guys do"

"We call it the hub of the college because students come here. They come here to ask every question under the sun. Current students, faculty, prospective, everybody comes in this office first because they usually come into this lobby and this is the first office they see. And if you…basically the idea here in the college is if you don't know how to answer a question go to the center and they will figure it out for you"

"We've got basically this building. We've got [program hall] which is two buildings down where Biosystems is. We have the research complex and we one or two sites out on [anonymous road]. But the majority of the people who collaborate on student programming issues are all sitting in this building or over in [building] which is a five-minute walk…We're just centrally located together…"

Organizational Structure of STEM Intervention Program
Where the program is housed organizationally essentially predicts how the STEM intervention program operates. The data reveals this aspect of STEM intervention programs is most critical to not only how STEM intervention programs are sustained, but also critical to how students locate and receive program services. Various participants provided examples of how their organizational structure varies. In regards to sustainability of STEM intervention programs, analysis of data also revealed that over time when the administrative structured changed, or another grant was received to continue the program, reporting and or support for the STEM intervention program changed as well. This resulted in an organizational shift in reporting structure, as well as daily operations.
Additionally if funding for STEM intervention programs changed, at times the structure of the organization changed as well. Programs can either lose or gain funding, which impacted staffing within the organizational structure. The following quotes below are examples of how the structure of particular STEM intervention programs is determined by not only on who

wrote the grant for the program, but also where the program also receives administrative support from higher level officials:

> "I am within the department of aerospace engineering because our grants are through them, our NSF and NASA grants are through them. And so since I guess through the NSF program I am still tied to the department because that's the departments grant, and not a space grant. Um I'm an academic professional, and so you've got the department head, and then you've got the academic and business offices, and I'm just kind of, and you have the development guy over here, I'm just kind of somewhere….this will get people really confused because since we did both things, they get confused at which program is which…"

> "And that fact that our interactions have-it was originally located in the Liberal Arts and Sciences, cause the PI was there. We moved to Medicine because [joe] and I, the other director in the [college], it was over here on this side of the river. The reason we put it in the graduate college actually was because it's to feed into them. And they provided probably the best structure for diversity in that, so…over there. But you know, we get support from the provosts, our evaluators, and the college of education…"

> "So [College] is under the Associate Provost for University Education. However we do not meet with them. We don't report to them, but on paper that's kind of where we are."

> "Because what happened, one of the things we heard our first year, because we had various people doing various things, often times people didn't realize well who do I go to for this or that. So we wanted to have a little bit more structure organizational format."

In addition to where the STEM intervention program is housed, there were instances where the program was not efficiently organized. Particularly reporting and communication structures were not conducive in figuring out programmatic duties and responsibilities. As result, some program directors engaged in re-organizing their structure to ensure organizational efficiency of day-to-day activities, thus increasing efficient of service delivery:

> "Um, I mentioned earlier, the fact that the organization was a little too loose, so we shored that up in terms of brining everything in house and identifying who's responsible for what"

> "Actually it's [impact of STEM intervention program] probably a little bit better because I think that they feel free to stop in anywhere they are. At first it was centralized for a while here, and it was easier for me. But in the end, I think because we have so many

> "One of the things we heard our first year, because we had various people doing various things, often times people did realize, well who do I go to for this or that. So we wanted a little bit more structure organizational format"

Participants in the study responded well to the general question, of where is the administrative structure of their respective intervention program located. We gain a sense that some STEM intervention administrative structure are located in a hierarchical structure, in which authoritative roles are determined and program directors report to a higher authority. However there are also instances in which the administrative structure was not defined, thus the type of organizational structure is unknown. Considering there were instances in which

the structure varies, it was difficult to pin point exactly the structure of the STEM intervention program.

Suggestions: Improving Organizational Structure to Increase Access

The findings support previous literature that the structure of programs (physical and organizational) impact service delivery. Particularly, where the STEM intervention program is situated within an actual college, department or center on campus impact location, day-to-day operation, which essentially impacts how services are delivered to students. Based on these facts, it is suggested that STEM intervention programs and administrative structure be centralized to allow students to easily locate program services. This will also allow for the development of essential relationships need to sustain STEM intervention programs. Particularly the reporting structure will be accessible to all students, faculty and staff. Thus making the organization more transparent. Additionally STEM intervention programs should be in a location that can be located physically.

In the event administrative structure and programs cannot be centralized, STEM intervention program directors should develop strategic marketing plans to advertise STEM intervention program/services across campus. Advertisement for program services should be posted in areas student easily access. Examples of common areas includes but is not limited to: Tutoring areas, counseling areas, and or food court areas Additional classroom presentations to engage students in opportunities will also introduce students to STEM intervention programs and services. Moreover program administrators, directors or staff must continue to develop networks between departments and the larger university in order to engage all constituents in program opportunities. By doing so, program administrators or directors will be able to compensate for not being able to centralize program services or administrative structure.

Lastly it will be beneficial to have a pre-determined reporting structure. This will allow for better communication between members of the organization. This will help sustain communication and daily operations in the event there is a shift in administrative roles and oversight of a STEM intervention program.

Conclusion

This paper examined how organizational structure may have an impact on the way in which opportunists are administered to students. STEM intervention programs are seen as a catalyst to fixing the high school to college, and college to career pipeline in science related fields. To this end programs will continue to be established in order to meet the national need of increasing the number of skilled laborers in STEM. Organizational structures can be effective if time is taken to strategically organize the program in a way to where it is meeting the needs of the students it intends to serve. Having a thoroughly developed organizational structure will impact organizational effectiveness in a way that will continue to meet the needs of the larger call of increasing the number of underrepresented students in STEM. Essentially ensuring these organizations run efficiently in order to continue to provide students the chance to engage and enhance their experience in the science related fields.

Acknowledgements

References

Bedeian, A. G. (1986). Contemporary challenges in the study of organizations. *Journal of Management, 12*(2), 185-201.

Berger, J. B. (2002). The influence of the organizational structures of colleges and universities on college student learning. *Peabody Journal of Education (0161956X), 77*(3), 40-59.

Blau, P. M. (1965). The comparative study of organizations. *Industrial & Labor Relations Review, 18*(3), 323.

Braun, V., & Clarke, V. (2006). Using thematic analysis in psychology. *Qualitative Research in Psychology, 3*(2), 77-101. doi:10.1191/1478088706qp063oa

Hage, J., & Aiken, M. (1969). Routing Technology, Social Structure, and Organizational Goals. *Administrative Science Quarterly, 14*(3), 366-377.

Hage, J., & Aiken, M. 1970. Social change in complex organizations. New York: Random House.

Hall, R. (1963). The concept of bureaucracy - an empirical-assessment. *American Journal of Sociology, 69*(1), 32-40. doi:10.1086/223508

Hurtado, S., Milem, J. F., Clayton-Pedersen, A. R., & Allen, W. R. (1997). Enhancing campus climates for racial/ethnic diversity: Educational policy and practice. *Review of Higher Education, 21*(3), 279-302.

Nahm, A. Y., Vonderembse, M. A., & Koufteros, X. A. (2003). The impact of organizational structure on time-based manufacturing and plant performance. *Journal of Operations Management, 21*(3), 281. doi:10.1016/S0272-6963(02)00107-9

Tinto, V. (1993). Leaving College: Rethinking the Causes and Cures of Student Attrition. (2nd ed.). Chicago: University of Chicago Press.

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

Ziskovsky, B., & Ziskovsky, J. (2007). Doing More With Less - Going Lean in Education. Retrieved from http://www.leaneducation.com/resources on June 5, 2012.

Author Information

Montrischa M. Williams, EdM., is a doctoral student in the Department of Education Policy, Organization, and Leadership at the University of Illinois Urbana-Champaign. Her research examines the impact of college readiness programs one the enrollment, persistence and graduation of underrepresented students in higher education. Montrischa can be reached via email at willia52@illinois.edu.