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STEM Bridges: Evolution of an Academic Library STEM Outreach Program

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ABSTRACT

Big Orange STEM Saturday (BOSS) is a sustainable model of outreach that fosters the STEM cycle of discovery and learning experiences. Through this program, the library creates and reinforces a bridge between secondary educational experiences and higher education that facilitates the transfer of knowledge from the classroom to the world. Local high school students are able to engage with experts in several different ways to explore what STEM has to offer and to look beyond their current experiences. This approach creates a venue for STEM teaching spaces outside of the school classroom for enrichment and innovation. Over the past 5 years, the variety of experiences offered at BOSS have expanded and the reputation of the program has grown. This article explores the challenges, lessons, and impact that this program has had on its constituents, with a particular focus on the impact the library can have when exploring nontraditional areas of support and outreach.

KEYWORDS STEM, outreach, academic libraries, secondary education, preparedness,

information literacy, career planning, community partnership, program review

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STEM Bridges: Evolution of an Academic Library STEM Outreach Program

Big Orange STEM Saturday (BOSS) is a mini-conference that presents educational and career opportunities in the STEM (science, technology, engineering, mathematics) areas and aims to prepare pre-college students for higher education classroom experiences. The event, held at the University of Tennessee, Knoxville, in the John C. Hodges Library, offers students a variety of potential STEM topics to explore in one convenient setting. Rich campus and community partnerships provide opportunities for students to have one-on-one conversations with researchers in the field, during which students discover the benefits of each area. During the three distinct program activities, students explore more specialized areas of STEM that are available as university majors and begin to envision their future careers. The university libraries host the conference, which allows librarians to collaborate with peers, other departments, and related organizations to construct a program that will promote and sustain strong relationships.

In the 5 years since its inception, the BOSS program has demonstrated growth and sustainability through a series of valuable STEM experiences that create a unique opportunity for teaching spaces outside the school classroom for middle and high school students. By benchmarking key components of the program (i.e., hosting a STEM conference for middle and high school students in an academic library, expansion of outreach efforts to include teachers, continual assessment and feedback of the program to ensure program growth), this article explores the challenges, lessons, and impact that BOSS has had on its constituents, with a particular focus on the impact the library can have when exploring nontraditional areas of support and outreach.

LITERATURE REVIEW

STEM topics are becoming more socially, economically, and politically charged, and careers in the STEM fields are currently trending in all facets of society. To determine the trend in STEM outreach publications, the research team performed a search query across multiple EBSCOhost databases, discovering that approximately 98% of articles in the databases concerning STEM education and outreach programs were published in the last 10 years, and 79% were published in the last 5 years. This increase in the literature is an indication of STEM's growing role in education across disciplines. According to Mack, Ruffin, and Barajas (2014), librarians and libraries are making an effort to address these needs by reaching out to K-12 students to become STEM leaders and researchers. Different outreach methods have been tested with various focuses, venues, and audiences, but out-of-the-classroom learning experiences have proven to be of great benefit to students (Thiry, Laursen, & Hunter, 2011). Additionally, when hosted by academic libraries, these opportunities have tended to also "maximize the perceived value of library engagement and library resources, including librarians" (Cantwell, 2014, p. 51).

Library Learning Spaces

The literature has demonstrated that library outreach programs occur for a multitude of reasons and, according to Schneider (2003), are based on three primary factors: an expressed need from outside the academy, a personal mission to pursue outreach initiatives within or outside the library, or to solve a particular problem or crisis. Additionally, there is a body of literature supporting the need to forge community relationships through library outreach. According to Meyer (2014), collaborating with outside partners "can enable the library to extend its reach far

more than acting alone" (p. 112). Such relationships with the community broaden the reach of the library, deepen the outreach mission, and create important precedents for sustainable community programming that incorporates information literacy at the pre-college and first-year studies levels. Strong partnerships along with outreach activities allow libraries to provide a valuable service to the university and community (Collins, 2009).

The literature also supports out-of-class learning experiences, as they "appear to have considerable potential for students' intellectual, personal, social, and professional development" (Thiry, et. al. 2011, p. 359). The University of Nevada, Las Vegas, created a hands-on learning experience for middle schoolers to reduce library anxiety. In place of a traditional library tour, the students engaged in a self-led ethnographic activity during which they made observations in the library and reported their findings. This independent approach added a unique layer of problem-solving, research, and discovery for students. At its conclusion, the students were able to call library staff by name, which suggested a reduction of library anxiety and a successful program (Godbey, Fawley, Goodman, & Wainscott, 2015). Oklahoma State University hosted a "National Lab Day" conference, during which high school students and teachers participated in hands-on STEM activities. The findings indicated that 21% of students who had previously attended the program majored in STEM fields in college (Angle, Colston, French, Gustafson, O'Hara, & Shaw, 2016). According to Thiry et. al. (2011), experiential learning opportunities help students to problem solve, develop literacy skillsets, and recognize the impact of a college education on career success. Additionally, hands-on learning experiences allow pre-college students to understand and prepare for their college experience (Cantwell, 2014).

The traditional audience for academic library services has been university students and

faculty, local researchers, and other general users. While there is much literature establishing this need at the collegiate level, there are fewer examples of established academic library STEM-based outreach at the pre-college level. Of the initiatives reviewed, most were larger-scale efforts attempting to connect library resources with STEM-focused high schools, such as the partnership between Ohio State University and the Columbus Metro Early College High School which sought to provide library resources for the school and demonstrate outreach and support for STEM-related initiatives (Herring, 2013).

Why STEM Outreach?

Kuenzi (2008) has spoken of the history of STEM preparedness in his report to Congress asserting the concern that students are not being sufficiently prepared in the STEM areas. Raines (2012) echoed a similar concern for today's global, technological, and competitive economy, stating, "it is essential that we strengthen the science, technology, engineering, and mathematics (STEM) skills of those who will be competing in the workplace" (p. 22). It has been well established by Rogers-Chapman (2014) that STEM preparation increases interest in STEM majors for all students, but in particular for underrepresented populations such as minorities and those from low-income backgrounds.

While there is an abundance of literature about STEM outreach, it is difficult to find library-specific examples, with the exception of the large-scale example set by Ohio State University. There are virtually no smaller-scale examples, such as the BOSS program, where the outreach focuses on groups of students rather than the middle or high school as a whole. As called for by Scaramozzino (2010) and Cantwell (2014), it is necessary for libraries to extend

their outreach to STEM-related initiatives that correspond with information literacy. It has long

since been the goal of academic libraries to increase information literacy among the students, but

now is the time for information professionals to refocus their efforts to include science

information literacy. Scaramozzino (2010) pointed out that this is a systemic problem—there is

little to no preparation in secondary education in information technology skills as they relate to

STEM career awareness.

THE BIG ORANGE STEM SATURDAY PROGRAM (BOSS)

BOSS was envisioned as an innovative way of communicating with students interested in

attending colleges and universities, particularly those with an interest in studying one of the

STEM areas. It was anticipated that this early exposure to a university setting would enhance

student engagement and excellence in research. The program was designed to meet an outreach

need for community learning services by expanding traditional instructional models to allow for

a more dynamic and experiential form of learning. One of the primary goals was to build a

scholarly platform for diverse and professional exchanges. This program unveiled the academic

potential of libraries as leaders in contributing to the STEM movement and mission of the

university.

BOSS is a one-day mini-conference consisting of a keynote activity in which students

learn a new skill guided by the presenter, breakout sessions in which students learn about hot

topics in STEM careers and education, and a STEM and Arts career fair where students engage

with exhibitors from a variety of STEM-related organizations. It is planned for several months in

advance and involves cross-campus partnerships and interactions with STEM vendors across the

state. The project began in 2012 as a way for the library to take a leadership role in preparing

high school students for the University of Tennessee academic and student life. What started as a

pilot initiative to explore the need for an outreach mechanism linking high school students to

university library spaces and programs has now developed into a cornerstone event of the

University of Tennessee Libraries.

Program Focus

There is a need for an interdisciplinary approach to the STEM areas for middle and high school

students, science professionals, parents, and administrators. Maintaining this focus allows the

BOSS program to provide students with a multi-layered learning experience that incorporates

both informational sessions with sessions that ensure student engagement. This focus was

addressed in two phases. The priority for Phase 1 of BOSS was to create a successful and

collaborative structure for the program. Much attention was given to framing the program,

including giving it a name that was both memorable and conveyed the intent of the program as

well as forming lasting partnerships with key groups. In order to ascertain feedback to build a

solid, long-term effort, the team created a survey instrument to distribute to participants. Students

and parents were invited to provide feedback about what worked well and areas that needed

improvement. Phase 2 involved applying the feedback and findings to improve the program for

future interactions. This has led to effective changes and more positive feedback from the

participants following each conference.

STEM was intentionally selected as the central discipline because of its growing

enrollment in universities, schools, and communities across the nation. BOSS was constructed to

identify habits that predict success in STEM fields such as collaboration, problem solving, and scientific literacy. The BOSS program also features a variety of STEM topics that introduce students and parents to the depth and reach of the fields. By focusing on STEM as the program theme, partnerships and program design were manageable and well-structured.

While the intended audience for this program was high school students, the BOSS organizers almost immediately received parent feedback that the event should also include middle school students. The interest level was so strong that the next BOSS conference in 2013 was expanded to include middle schools. This has continued so ever since, resulting in significant growth with a record 64 participants by 2016. Including a number of middle school students presented a programming challenge to find the right balance between information for students preparing to enter college and general STEM topics for those younger, but still interested, students who were several years away from graduating from high school. Increasing the hands-on programming activities and decreasing the number of lecture-style sessions helped bridge this gap. The keynote was successfully transformed from a lecture to hands-on activities. During the last three iterations of the program, students have participated in a DNA creation simulation, formed slime polymers, and programmed computer games. Parents were encouraged to attend the sessions as well, which is uncommon for this type of pre-college conference. This unique approach has also allowed BOSS to sustain its program goals and mission.

RESULTS

Assessment of BOSS attendees' experiences has played a major role in informing the program's evolution. Over the past 5 years, attendees have been surveyed to learn how to best refine the

program and better meet their needs. For example, the 2016 BOSS program allowed participants

to pre-select their sessions. By having registrants select their breakout sessions prior to attending

BOSS, it was determined that the greatest interests within this particular group were in

understanding the experience of undergraduate engineers and receiving information on career

development. At the event, the collection table for surveys was separated from the registration

area to ensure participants were not unduly influenced by involved parties. Toward the end of the

event, participants were encouraged to return the surveys. Overall, there were 52 responses.

Additionally, in 2016, the BOSS team took advantage of the features of the registration page to

distribute consent forms before the conference. The registration process alerted participants to

this impending paperwork, and as a result many participants made the effort to bring their

completed consent forms to the conference. This was also beneficial to the team because it

helped to fulfill a significant part of the IRB compliance. The re-designed registration page also

allowed the team to regulate participant distribution in each session and get feedback on topics of

interest from participants.
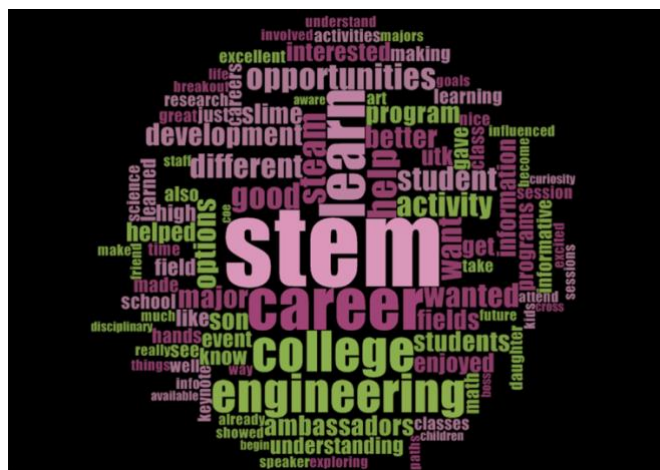
FIGURE 1 Word frequency word cloud.

The results of the survey were analyzed using NVivo software. A rough analysis of the words most used throughout responses supports the idea that participants easily identify with the purpose of the program. The most frequently used terms include STEM, career, college, and engineering, with development, opportunities, major, and options presented as other often-used terms (see Figure 1).

Two members of the four-person team coded each of the responses to find significant themes by section. They found that overall participants seemed quite pleased with the program. In particular, participants explained that they came to BOSS for a variety of reasons. Of 52 responses, 23 indicated they were attracted by its emphasis on STEM topics, 15 were influenced by career development information, 7 were interested specifically in engineering, and 6 either had it recommended to them by friends or attended with friends or family members (see Figure 2).
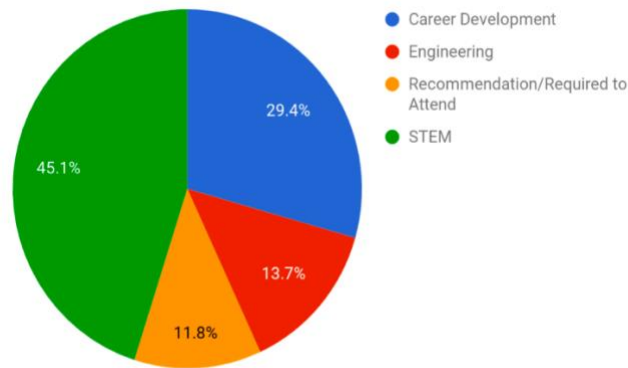

FIGURE 2 Reasons for BOSS participation.

Participants were also asked to consider how the event influenced their college or career goals. Of the responses, 18 indicated they now had a better understanding of STEM areas. Of those 18, 2 indicated directly that they had increased STEM knowledge, and 8 indicated they had

increased engineering knowledge. Additional respondents indicated they had more understanding

of aspects of career planning (13), and college preparation (10) (see Figure 3).
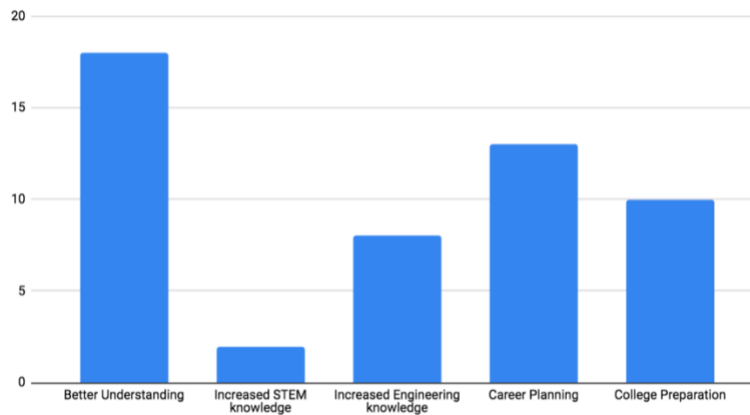
FIGURE 3 Influence on college and career goals.

In exploring what participants most enjoyed during the event, it was found that 36

respondents most enjoyed the breakout sessions, 19 respondents most enjoyed the keynote

activity, 3 respondents were vague or enjoyed everything, and 2 respondents most enjoyed the

breakfasts and/or breaks. In exploring the popularity of the breakout sessions, 9 respondents

seemed to enjoy the career-development session, 9 respondents enjoyed the College of

Engineering Ambassadors session, 8 respondents enjoyed the STEAM (science, technology,

engineering, arts, mathematics) presentation, and 3 enjoyed the math session. It is to be noted

that career development and the College of Engineering Ambassadors had the highest level of

attendance, while the others had lower attendance, with math representing the smallest group of

participants (see Figure 4).
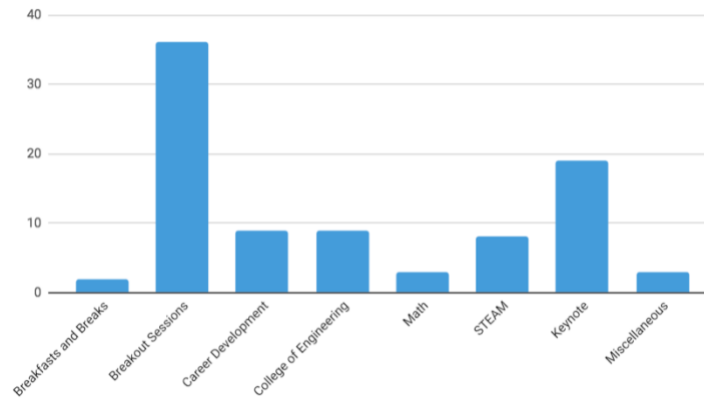
FIGURE 4 Aspects that participants most enjoyed.

Participants were also given the option of providing additional comments that provided greater insights. Of these comments, 14 indicated how much they enjoyed the event. Three comments requested more hands-on and more interactive events. Two commented on the excellence of the career planning and college preparation focus of the event, two more on the excellence on the exhibitors at the event, and two comments indicated either a like or dislike of the keynote presentation.

LESSONS LEARNED

The administrative infrastructure has been expanded from just the co-conveners and a graduate student to a full committee to plan and manage the program elements and rethink the programming topics in a more global way. Distributing work to different members of the committee allows for creativity and the cultivation of new ideas. This was particularly evident in the management of the registration page and its features, which helped to develop a system to keep the page dynamic and interactive throughout the year. In addition, the talent of the

donations team in soliciting donations allowed greater latitude in the dissemination of prizes to participants. When the team conquered the project through an appropriate division of labor, time consuming tasks, such as IRB submissions, were done more quickly and productively.

A significant lesson learned was that the right partnership connection was key in sustaining the life of the initiative. Good partnership practices allowed the BOSS team to stretch their resources and acquire supportive funding. Additionally, partnering with a mixture of organizations like Oak Ridge National Laboratory, STEMspark, and UT Admissions rendered a new level of interest with the key populations. Involving ambassadors who have participated in and supported the program in the past helped to surpass a theoretical view and transition to a concrete, pedagogical application (see Figure 5).

This paradigm results in a model of information sharing and resourcefulness for successfully promoting library STEM outreach and partnerships. This program allows for like-minded educators to establish a practice for strengthening STEM learning experiences. Through this program, the BOSS team can analyze the communication expressions and exchanges among the various entities at the event. These connections spur new partnerships that lead to richer research collaboration and professional practices. As a result of these partnerships, the library is engaged in more collaborations that enhance our campus-wide outreach efforts and create awareness of resources within the library that have not been fully utilized.
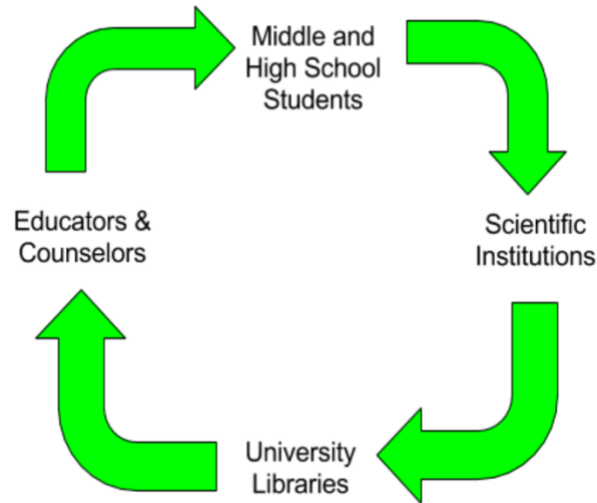
FIGURE 5 BOSS information sharing power center.

ROLE OF THE LIBRARY

BOSS continues to support student transition from K-12 to college. This unique program comes together in an academic library, exposing pre-college students to the benefits and resources of the academic library as well as the scholarly expectations of a college campus and community. Using library spaces to design and facilitate conferences for high school students changes traditional mindsets about how libraries can promote college preparedness. Librarians, and what they do, are still mysteries to many departments on campus. The BOSS model allows not just the attendees to gain new knowledge of the mission and services of a library, but it also allows participants from campus departments to see librarians as leaders of student success and engagement. This understanding provides libraries the opportunity to work with colleagues toward the reality of learning and success goals of future university students.

FUTURE DIRECTIONS

After 5 years of BOSS, these research collaborations have expanded to include an invitation to create a mini-conference for educators and guidance counselors, the Big Orange STEM Saturday for Educators (EduBOSS), which provides learning and engagement outside of the classroom and parallel to BOSS. The team was approached by STEMspark, a regional partnership of educational, business, scientific, and research institutions and organizations to collaborate on a new paradigm for sharing STEM learning experiences and dialogue among educators. This program offers an expansion of the BOSS programming efforts for middle and high school students which institutes a cycle of knowledge between K-12 schools and universities (see Figure 5). It presents a platform for emerging STEM literacy elements and practices. By bringing together different personnel, a blending of skill sets will take place that all participants can apply in their specific roles.

The EduBOSS program establishes an infrastructure that allows the teachers to participate in an experiential learning method to model for their students and schools. Being exposed to hands-on opportunities allows participants to transfer more knowledge and scientific information to students. Having this pilot effort in effect allows for the dissemination of the findings with other universities and interested parties. This may inspire colleagues to design programs that would allow them to review and enhance their STEM outreach missions. EduBOSS will shape and design a practice that will put a standard into place so that students get consistent information and guidance about STEM college expectations and careers. The educators have an opportunity to understand the complexity of higher STEM education so they can provide counseling and advice to their students. Additionally, this is an opportunity for

education professionals to clarify the roles of their colleagues. By bringing together a wide variety of participants such as STEM career counselors, librarians, guidance counselors, educators, admissions officials, and STEM administrators, BOSS presents a unique approach to outreach and partnership. Different levels of scholarship will be applied to further support actions and practices for participants to take away. This initiative will solidify a standard of practice and dialogue among various entities of the STEM communities. It will also help to meet higher education goals and missions by guiding more high school students to a successful college admissions process and introduce them to the array of STEM majors.

As BOSS moves forward into its sixth year, the BOSS team looks forward to growing and developing the curriculum to include new partnerships, trending topics, and new innovations in STEM. Through these developments and initiatives, BOSS continues to demonstrate sustainability and growth through the library's commitment to STEM preparedness outside of classroom.

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