© *Journal of Higher Education Outreach and Engagement*, Volume 22, Number 3, p. 185, (2018)

Lessons Learned from the STEM Entrepreneurship Academy

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Abstract

This article describes the STEM Entrepreneurship Academy, a week-long summer camp that exposes students from the Black Belt region of Alabama to a college campus and opportunities in the STEM disciplines. A unique feature of this program is the entrepreneurial focus on STEM. Students interact with university faculty, staff, and students while participating in a variety of hands-on activities. They are also charged with designing a final project that integrates the content they have learned over the course of the week. A descriptive analysis of the students who participated reveals several things. Students who participate exhibit a high interest in STEM careers, with females showing a significantly stronger interest in medical-oriented fields. Lessons learned include the importance of exposing students to college campuses, offering more STEM opportunities, and strengthening partnerships with high school educators in rural communities.

Keywords: STEM, rural education outreach, engagement

Introduction

Traditional instructional practices found in schools today have not adequately prepared students for current college and workforce demands *(Hmelo-Silver, 2004; Ronis, 2008; Soulé & Warrick, 2015)*. Many students are now entering the workforce or college unprepared and thus lacking the 21st-century skills needed to be successful with the ever-changing demands of adult society *(Greenhill, 2010)*. In a recent report, the President's Council of Advisors on Science and Technology *(PCAST, 2012)* noted that a large gap exists between the demands for citizens prepared to work in STEM (science, technology, engineering, and math) fields and the inadequate preparation in both K–12 and higher education. Students frequently lack the ability to think critically or problem-solve in novel situations. In addition, employers have commented that students have limited life and career skills, such as flexibility and adaptability, initiative and self-direction, social and cross-cultural skills, and leadership and responsibility *(Greenhill, 2010)*.

These skills are especially critical in the STEM fields as openings within these areas continue to grow. Over the past decade, STEM-related jobs have seen growth nearly double that of all other fields *(U.S. Department of Labor, 2007)*. Economic projections display a need for approximately 1 million more STEM professionals than the United States will produce at the current rate over the next decade (PCAST, 2012). In addition, a large percentage of baby boomers in STEM occupations are nearing retirement, which presages a further increase in the number of job opportunities available to prospective graduates *(Barton, 2003; Crisp, Nora, & Taggart, 2009)*.

Despite the increasing demand for qualified workers in STEM-related professions, students continue to gravitate to collegiate degrees in non-STEM fields. The science indicator released by the National Science Board *(NSB, 2010)* indicated that one third of bachelor's degrees awarded in the United States were in a STEM field. Women and other minority groups are particularly underrepresented in STEM fields. According to the NSB's *Science and Engineering Indicators 2010*, the data indicated that 80% of bachelor's degrees in engineering, computer science, and physics were awarded to men. In addition, White students were awarded 64% of science and engineering degrees nationwide.

Many states have also seen a dramatic change in the demographic makeup of their student population in the past decade; however, large "graduation gaps" still exist between White and minority students in many states. According to Johnson and Strange *(2007)*, Alabama is one of 13 states where rural education is most important to the overall education performance of the state, yet it is among the four states least conducive to rural education achievement. In the same study, Johnson and Strange surmised that the poorer and more diverse the rural student population, the lower the rural NAEP (National Assessment of Educational Progress) scores.

Students from K–12 schools in rural areas also face many additional challenges. Rural schools often must transport students over long distances. Hours spent traveling before or after school may limit time spent on additional activities or opportunities *(Lindahl, 2011)*. Rural schools often face financial hardships. In fact, per-student expenditures are lowest in southern states *(Johnson & Strange, 2007)*.

To address the ongoing underrepresentation of minority and rural students among the college bound, educational institutions and service organizations are developing creative, innovative programs for this population. These programs expose students to relevant opportunities and help them develop the required skill sets for entering these fields.

This study was performed to conduct an outcome assessment of one session of the STEM Entrepreneurship Academy. The academy is a week-long residential summer camp developed for high school students in Alabama. Participants are chosen based on their high school's location in the most impoverished section of the state, the Black Belt region. The goal is to determine the impact of the academy on these students in the following areas: their interest in STEM fields, their self-efficacy in STEM, and their plans to pursue a college degree and/or a college degree in a STEM field.

Literature Review

Need for Science, Technology, Engineering, and Math (STEM) Education

STEM skills are required to be competitive in today's global era. Knowledge in STEM fields is in higher demand than ever before. Because technological and scientific innovations affect our lives and provide economic benefits, students should be equipped with STEM knowledge, skills, and abilities *(U.S. Congress Joint Economic Committee, 2012)*. According to Kodable *(2016)*, over the next 10 years there will be 1.4 million programming jobs to fill with less than one half million graduates in computer science. Further, the National Academy of Sciences study *Rising Above the Gathering Storm (National Research Council, 2007)* addressed concerns that, absent a serious response, the United States will lose quality jobs to other nations due to an underprepared workforce.

Student data in K–12 schools continue to indicate a deficit in both mathematics and science learning. In fact, Alabama is one of 12 states that has the lowest average score on both the math and reading NAEP test for rural schools *(Johnson & Strange, 2007)*. Low-income students and those in rural schools may have less access to technology due to lack of funding for computers or lack of connectivity to the Internet *(Lindahl, 2011)*. This presents a great educational barrier when a free website offers elementary students the opportunity to learn to code as early as kindergarten.

Rural Education

In the United States, half of all rural students live in just 10 states: Texas, North Carolina, Georgia, Ohio, New York, Pennsylvania, Virginia, Alabama, Indiana, and Michigan *(Bhatt et al., 2018)*. With almost 96% of its land area and 41% of its population classified as rural by the 2010 U.S. Census, Alabama is a state that is overwhelmingly identified as rural *(U.S. Census, 2010)*. According to Lindahl *(2011)*, several types of issues are known to affect students in rural schools: transportation issues, socioeconomic issues, and funding issues. Of Alabama's 67 counties, 55 are classified as rural, which indicates that many students travel long distances to school each day *(U.S. Census, 2010)*.

Poverty is known to be a critical factor contributing to the achievement gap between White students and minority students in rural and nonrural populations *(Ladson-Billings, 2006)*. More than one in three Alabama students attend school in a rural district, one of the highest rates in the nation; nearly six in 10 of the state's nearly 265,000 rural students live in low-income families *(Showalter, Klein, Johnson, & Hartman, 2017)*. In a national study by Farmer et al. *(2006)*, it was noted that in over 40% of the rural schools serving poor, minority youth, a disproportionate percentage of African American students did not pass their end-of-course exams and were in danger of dropping out of school. In Alabama, this holds true as the state exhibits the nation's lowest score for rural students in both 4th and 8th grade math *(Showalter et al., 2017)*. Rural schools have a history of lower expenditures per pupil, particularly in southern states. Alabama's annual rural instructional expenditure per pupil of about $4,800 and educator salaries averaging just under $50,000 are among the lowest in the nation *(Showalter et al., 2017)*. In addition, rural schools typically lack the large tax base or local supplemental revenue needed to augment state funding *(Lindahl, 2011)*.

Partnerships

With the current lack of resources, funding, and opportunities in today's schools, there has never been a greater need for effective school, family, and community partnerships. Research has shown that student achievement and social competence improve when schools, family, and communities work together to promote student success *(Epstein & Sanders, 2000; Sheldon & Epstein, 2005)*. In order to provide for current needs, such as STEM education and those found in rural schools, it is critical to form partnerships beyond the school level and include families and communities in order to fully realize students' potential.

Program Description

The primary goal of the STEM Entrepreneurship Academy (SEA) is to expose students to the concepts of integrated science, technology, engineering, mathematics, and entrepreneurship. Through this exposure, children can discover options in the STEM and entrepreneurship fields. SEA is a residential, week-long academy on a college campus during the summer that students from high schools in rural west Alabama and the Black Belt region of Alabama attend by invitation.

Each day, students participate in content-related sessions that are facilitated by faculty members from the sponsoring university. The sessions are designated for each of five areas: science, technology, engineering, math, and entrepreneurship. Sessions are hands-on, laboratory-based, and connected to the world of entrepreneurship. Students who participate in the academy engage in activities and work to find meaningful, real-world solutions to questions presented during the labs. At the end of each day's activities, students travel to a computer lab to participate in a live chat session using the Google Classroom platform. Students respond to a series of questions about the day's activities while graduate assistants facilitate questioning and probe for deeper responses.

In order to encourage connections to STEM-related careers, students participate in a career assessment/inventory and a career fair. The career assessment/inventory is conducted by the sponsoring university's Career Center staff and includes simulated job tasks for each student's assessment results. The career fair includes representatives from each of the sponsoring university's colleges and divisions, including campus representatives from departments such as housing and Early College.

Entrepreneurial sessions are led by a doctoral student facilitator in conjunction with partnerships with the chamber of commerce and the city's local entrepreneurship center. During these sessions, student teams design a product or service that addresses a problem in their school or community. This project culminates in a presentation that is shared with fellow campers, parents, university staff, and community members at a closing program. These presentations are archived and shared with school administrators and district personnel for each participating school.

Students also participate in social activities throughout the week in order to maximize their campus residential experience. Activities are planned in the student recreation center, the local bowling center, and the student commons room. In addition, hands-on activities are planned with a local technology center that includes robots, interactive whiteboards, and 3D printers.

Participants

Students who attend the STEM Entrepreneurship Academy are recruited through the sponsoring university's Center for Community Partnerships. The academy was developed to support students in a specific geographic location that encompasses schools in low-income, high-needs areas. All schools selected for the academy are designated as Title I schools based on their percentage of students who qualify for free or reduced-price lunch. The director of community education at the center partners with principals and teachers at each of the selected 11 high schools to choose students who may have shown interest in a STEM content area but lacked full exposure. In the session studied, 40 students from 11 high schools in eight counties were selected to participate in the program.

Staff

The director for the academy is the director of community education for the center for community partnerships. The director oversees all coordination and administration of the camp, including planning, staffing, leading, and recruitment of campers. One program coordinator supports the director to perform administrative duties related to the camp. One doctoral student serves as the entrepreneurship facilitator and facilitates the entrepreneurship sessions for all campers. Four camp counselors and two graduate assistants serve as on-site staff during the week and provide support as table facilitators, monitors, and residential leaders.

Research

Research is one way that organizations can ask and answer meaningful questions about the programs they create and the experiences they afford to participants. It is important to plan for and gather programmatic information that can be used to evaluate outcomes and the impact on participants. This supports additional funding for relevant programs as well as providing opportunities for refinement, revision, and replication.

Institutional Review Board (IRB) approval was obtained to allow for collection and analysis of data. Parents received and completed consent forms during camp drop-off, and students who had permission were able to participate in the research during the camp. Student assent forms were obtained during the opening session of the camp. Students completed surveys at the beginning of the camp that addressed their self-efficacy as it related to STEM content areas, their attitudes about STEM, their interest in specific STEM professions, and their college and career aspirations. Survey items used a Likert response scale from 1 to 5, with 1 being strongly disagree and 5 being strongly agree. At the end of each day's camp activities, students were also engaged in an online chat group to share their general impressions. The transcripts were reviewed and patterns identified. In addition, anecdotal notes were made from informal conversations throughout the week.

Research Questions

In order to obtain a better picture of the students being served by the STEM camp, the following questions were explored: Is there a relationship between gender and interest in STEM disciplines? How do students from the Black Belt counties talk about STEM in relationship to their communities and their personal goals?

Descriptive Data

A descriptive picture of the students who attended the camp is provided. Table 1 lists the demographic variables of the students who participated in the camp. The number of girls who attended the summer STEM academy was somewhat higher than the number of boys. The majority of campers who participated were new to this camp experience. Eleven high schools from the Black Belt counties were represented, with two to five students from each school. There was a fairly even spread of 10th through 12th graders, with the majority of students being 11th graders.

Table 1. Demographic Variables of Sample

Variable	Description	***N*** ***N***=36	Percentage distribution in sample
Gender	Male	15	42
	Female	21	58
New or returning camper	New	24	67
	Returning	12	33
High School Attended	ALJHS	4	11
	AHS	2	6
	CHS	4	11
	FCHS	3	8
	GCHS	3	8
	GHS	4	11
	HCHS	4	11
	HHS	3	8
	OHS	5	14
	PCHS	2	6
	SCHS	2	6
Grade	10th	10	28
	11th	16	44
	12th	10	28

Survey Items

Reponses on the Student Attitudes Toward STEM (S-STEM) measure (Friday Institute for Educational Innovation, 2012) looked at self-efficacy in math, science, 21st-century learning, and interest in various STEM fields. Overall, students had moderate to high self-efficacy in math (M = 3.35, SD = .34), science (M = 3.61, SD = .77), and 21st-century learning (M = 4.43, SD = .46). As a group, students in the camp had a moderately low interest in STEM professions (see Table 2).

Table 2. Interest in STEM Careers (*N* = 36)

Area of interest	Mean	SD
Physics	2.36	1.02
Environmental work	2.47	.74
Biology & zoology	2.74	1.01
Veterinary work	2.25	.81
Mathematics	2.78	1.07
Medicine	2.81	1.14
Earth science	2.14	.77
Computer science	2.50	.97
Medical science	2.64	1.05
Chemistry	2.47	1.00
Energy	2.17	.97
Engineering	2.86	.96

The first question explored whether there were gender differences among the participants in the STEM academy. Chi-square analyses were used to look at differences between areas of interest in STEM. As seen in Table 3, the percentage of participants interested in most STEM fields did not differ significantly by gender. However, for medicine-related disciplines there was a significant gender difference in level of interest. Females showed more interest in both medicine [$x^2(1, N = 36) = 6.61, p > .05$] and medical science [$x^2(1, N = 36) = 9.26, p > .05$]. It is important to note that because of the small sample size these differences must be interpreted with caution. A larger sample may yield different findings. All students reported a plan to attend college, most at 4-year institutions within their home state.

Table 3. STEM Area of Interest by Gender, According to S-STEM Questionnaire

STEM area of interest	Males (*N* = 15)				Females (*N* = 21)				X^2
	Interested		Not interested		Interested		Not interested		
	N	%	N	%	N	%	N	%	
Physics	6	17	9	25	7	19	14	39	p = .681
Environmental work	6	17	9	25	12	33	9	25	p = .310
Biology/ zoology	8	23	6	17	14	40	7	20	p = .568
Veterinary medicine	5	14	10	28	8	22	13	36	p = .769
Math	9	25	6	17	12	33	9	25	p = .864
Medicine	5	14	10	28	16	44	5	14	p = .010
Earth science	4	11	10	29	7	20	14	40	p = .766
Computer Science	6	17	9	25	10	28	11	31	p = .650
Medical science	3	8	12	33	15	42	6	17	p = .002
Chemistry	5	14	10	28	9	25	12	33	p = .563
Energy	6	17	9	25	4	11	17	47	p = .166
Engineering	13	36	2	6	12	33	9	25	p = .058

The second question we hoped to answer was more qualitative in nature as we tried to gain a better understanding of how our students perceived their experiences with STEM and their personal goals within STEM. Although students appeared to be highly motivated and interested in STEM, they anecdotally reported having little or no access to high-level instruction in advanced curricula. Participation in such programs frequently involved travel to a district center, which was not always available. This was especially problematic for those students in county schools located farther away from metropolitan areas. Students in smaller counties also discussed high teacher turnover and absences, particularly in math and science disciplines. Students expressed frustration around this issue, as they felt they were being inadequately prepared for the rigor and demands of college.

Despite this frustration, students were hopeful about their futures and able to articulate goals. As demonstrated through their final projects, most students felt a need not only to be successful but also to give back to their schools and surrounding communities. Through their lessons on entrepreneurship, participants gravitated toward social entrepreneurship and designed projects that met a need either in their home schools or larger communities. Examples of projects included a food pantry for needy students, a school-based recycling program, tutoring and test prep services, and an after-school engineering club. To support sustainability of student projects beyond the camp, several strategies were implemented. The Google Classroom platform was added to camp activities to allow continued communication and collaboration with students throughout the school year. In addition, project plans were shared with teachers and administrators at students' home schools along with a letter requesting their support of student implementation efforts.

Based on this early impact study, several adjustments were made to the selection process for future academy sessions. First, the decision was made to focus on rising sophomores and juniors in hopes of piquing their interests in STEM earlier in their high school career. Second, selection of future participants will give priority to students who have never attended the academy before. This will permit a focus on the academy's effectiveness over time as opposed to having to modify the curriculum for repeat attendees. Finally, more emphasis was placed on utilization of the Google Classroom platform during the course of the camp and for ongoing communication after the session ended. Continued university support and support garnered from school and community partners will allow this program to continue.

Key Takeaways From STEM Entrepreneurial Academy

Through research on our efforts with the SEA, we gathered four overall takeaways to guide future executions of the academy. These takeaways will help with future recruitment and coordinating activities. Overall, we learned of the importance of exposure to a collegiate environment, ensuring access to resources and opportunities within the community, strengthening the entrepreneurial aspect of the academy, and building a relationship with our high school partners.

Key Takeaway 1: Importance of Exposure

The primary focus of SEA has been to expose participants to STEM fields and careers. However, the program has utilized a broader focus to accommodate the backgrounds of most participants. Many of the participants come from households with parents who are not college educated. For these students, exposure to a college campus is more important than exposure to STEM fields specifically. Some participants had unchanged interest in STEM fields between the pre- and posttests. However, they learned about areas within STEM (e.g., biomedical engineering) that they had not previously encountered. Some of the participants expressed their interest in the program as it relates to their desire to be college graduates one day.

Key Takeaway 2: Access to Resources and Opportunities

Many of our students come from school districts and counties with little to no access to resources and opportunities that encourage college admission. Offering sources of information on not only college admission, but also on programs the students can participate in during their high school tenure, was important to the leadership of SEA. In the session studied, the academy instituted a resource fair where participants could learn about different departments on the sponsoring university's campus. The resource fair included a representative from the university's Early College program, which enables high school students to work on college credits. The resource fair was instituted because students had indicated a lack of information within their school districts regarding opportunities that would prepare them for college. In addition to this resource fair, a Career Services representative from the sponsoring university also made a presentation to the students. Her presentation was centered on inspiring the students to think about which careers would best fit their interests. This collaborative effort between the academy and the sponsoring university was crucial to ensuring that the participants had a successful interaction with resources and potential opportunities to guide them before and during the college admission process *(Frerichs et al., 2017)*.

Key Takeaway 3: Strengthened Entrepreneurial Focus

In the past, SEA has mainly focused on introducing participants to the idea of STEM entrepreneurship, with a majority of the emphasis being placed on exposure to STEM fields. The program has since placed a greater emphasis on its entrepreneur aspect by requiring participants to create realistic projects that can be implemented by their school teams during the school year. This strengthened focus on entrepreneurship will involve SEA's partnership with the local entrepreneurship center. SEA has utilized this center to help the participants prepare for their final presentation. This increased emphasis on the entrepreneur aspect of the academy will necessitate strengthening the partnership to become more hands-on with the participants in future programs.

Key Takeaway 4: Relationship Building With High School Educators

In the year studied, the SEA program extended an invitation to the participants' science teachers to come and assist with their entrepreneurial projects. The project directions called for a more hands-on approach, which required the participants to take their projects back to their schools for implementation. Although teachers were offered a daily stipend and daily travel reimbursement, less than 50% of participating schools had a teacher representative in attendance. Summer plans and circumstances beyond the control of the program (e.g., educators who had changed schools and/or districts) accounted for lack of participation by teachers in late July. Participants who did have a representative science teacher during the week were excited and open to the collaboration, thus leading to a greater likelihood of project implementation upon return to their schools. Having consent and buy-in from the educator is important to ensuring that students are focused on implementing their project during the school year. In the future, educators' continued support will be an essential consideration for long-term project sustainability and community collaboration.

Discussion

This research was driven by two questions. The first question concerned gender and interest in STEM fields. We found no significant difference between genders regarding overall interest in STEM fields. However, female student participants showed more interest in medicine and medical science than the male participants. It is important to note that due to a limited sample size, this relationship may not hold for larger samples. However, this relationship remains an important consideration for planning content sessions and activities for future programming of SEA.

The second research question explored the perceived experiences with STEM and personal goals within STEM. The results of our survey point to a high interest in STEM fields among the student participants in SEA. Using a week of planned activities to cultivate this interest by helping students discover the options in

STEM and entrepreneur fields, SEA provided access to resources and opportunities that many of the students indicated they lacked.

With the focal goal of exposing the students to the concepts of integrated science, technology, engineering, mathematics, and entrepreneurship, SEA has demonstrated its ability to support rural education in west Alabama and the Black Belt region. Through the community partnerships with high school administrators and teachers throughout the target region, SEA has provided student participants STEM-related sessions facilitated by university faculty and entrepreneurial sessions facilitated through partnerships with the chamber of commerce and the local entrepreneur center. These community partnerships have contributed to student achievement and social competence *(Epstein & Sanders, 2000; Sheldon & Epstein, 2005)*.

By building on the key takeaways, SEA will continue to make necessary adjustments to ensure the academy is serving the needs of the students within rural west Alabama and the Black Belt region. Ensuring that these students will be prepared for jobs within the STEM fields is essential to meeting the demands of the changing job market. Acknowledging the importance of exposure, access to resources and opportunities, strengthened entrepreneurial focus, and relationship building with high school educators is how SEA desires to make the program more valuable to the students it serves. Next steps will include looking for funding sources to conduct a replication study in South Carolina with high school students from rural counties and examining the impact of the academy on students over time through a longitudinal study.

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