# The Impact of the Science, Engineering, and Technology Gateway of Ohio (SETGO) Program Mentoring on Student Attitude Changes and Retention

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## Abstract

*The SETGO (Science, Engineering, and Technology Gateway of Ohio) program includes a three-tier approach to increasing the total number of students entering and matriculating through Science, Technology, Engineering and Mathematics (STEM) degree programs. Findings of this research suggest that there are multiple pathways that can lead to increased motivation, retention and engagement in STEM. However, one-on-one or small group mentoring has shown to have a greater impact than any other method. Mentoring by faculty, graduate students, and peers all impact attitudes towards STEM degrees and persistence toward graduation.*

**Key Words:** Retention, Attitudes, Mentoring, Science, Mathematics

## *1. Introduction*

There is national concern about the long-term impact of the attrition of undergraduate students in the STEM disciplines. In fact, among entering college students, interest in STEM majors dropped from 11.5% in 1966 to 5.8% in 1988, and continues to decline (Seymour & Hewitt, 1997). Moreover, a full 40-60% of entering STEM majors switch paths shortly thereafter. Even more troubling is the data showing a lack of graduation of women and minorities in the STEM fields (Bae & Smith, 1997; Farrell, 2001; Hayes, 2002; Tyson, Lee, Borman, & Hanson, 2009). Although such attrition includes students who are unprepared for the demands of STEM curricula, additional factors are invariably involved. A failure to find remedial help to bridge the gap distinguishes switchers and those who persist, particularly among the so-called "over confident and under-prepared" minority students from high schools predominantly attended by students of the same ethnicity (Seymour & Hewitt, 1997).

Furthermore, women leave because of a lack of interactive learning opportunities and rapport with faculty (Seymour, 2005; Seymour 1997; Seymour & Hewitt 1997). Frome et al., (2006) demonstrated that young women abandon STEM studies primarily because of concerns about balancing career and family, and not because of differences in abilities, attitude or work ethic (Seymour 2002; Handelsman et al., 2005). Thus, encouraging women is not enough; they need role models who are successfully balancing male-dominated careers and families. Curtailing attrition and increasing the production of well-qualified STEM graduates requires a three-pronged attack on issues of accessibility, preparation, and interest in science/math

## *2. Review of Literature*

Recent technological advancements in science and mathematics have increased the need for STEM employees but there is a shortage of students qualified to fill these needs (Tyson et al., 2007).

Recent studies have found female achievement rates in STEM disciplines have increased but the retention rates do not increase, and the same is said for minority students in STEM (Huebner, 2009; Drane, Smith, Light, Pinto, & Swarat, 2005). There is significant data showing that graduation rates in the STEM disciplines are reduced compared to other majors and particularly so amongst females and minorities (Hayes, 2002). This is of further concern because the shortage of women and under-represented minorities in STEM fields extends also to graduate school (Ferrell, 2001). These widespread concerns about student retention in the STEM disciplines highlight a need to investigate the reasons some persist.

To address the issue of attrition among STEM majors, the National Science Foundation has funded several programs to help raise the rates of students leaving the STEM disciplines. The programs provide support, practice, and interest for students pursuing a STEM major. Tyson et al. (2007) suggest that students who take mathematics and science in high school begin on the pathway to the STEM majors and will continue in college. The students are believed to continue on the STEM pathway because they have already established a challenging course sequence in high school and their chances of achieving a STEM major are greatly increased.

### 2.1 Successful mentoring programs

Preparing students for college has been a focus of several studies to investigate how preparation courses can increase student enrollment and attainment among the STEM disciplines (Herzog, 2005). Many programs have been created to recruit high school students to attend college majoring in the physical sciences and engineering by offering a free weeklong summer science camp. One example, PR2EPS, consisted of a free walk-in chemistry and physics tutoring center, equipment loan program for secondary science teachers, and scholarship opportunities for students entering college as a freshman. The project has shown positive evidence, thus far, on the retention of freshman and sophomore STEM students, with 90% of students in the project staying in their original STEM major to graduation (Felix & Zovinka, 2008; Bachman et al., 2008). Another successful summer bridge program is Emerging Ethnic Engineering at the University of Cincinnati, which prepares incoming freshman engineering students from underrepresented ethnic populations. Students worked in four to five member heterogeneous groups that foster peer support and prepare them for freshman and sophomore science and math classes at the college level (NSTA, 2009).

Yet another, mentoring program closely examined in our planning of the SETGO program is the Academic Investment in Math and Science (AIMS) program at Bowling Green State University (Gilmer, 2007). The university noticed an alarming trend of women and under-represented minorities completing STEM degrees. The AIMS program was designed with an intensive 5-week bridge program and follow up academic year mentoring to increase the likelihood of retention. This program has been very successful in retaining and graduating more than 90% of its participants to date. The AIMS program utilizes peer and faculty mentors, research experiences in faculty laboratories, weekly AIMS seminars and study groups to increase student success. As with other programs, AIMS has found a strong correlation between success in mathematics and retention and persistence in STEM majors; thus they have a strong focus on mathematics skills and coursework (Adelman, 2006).

Students need to have constant exposure to real life science experiences to stay motivated and interested in STEM disciplines. The interest levels of students pursuing a STEM major tend to decrease in the first two years of college. Likewise, the attrition rates for college freshman and sophomores are highest during these times, which are when most introductory science courses are taken. To address the attrition rate in the early years of college, a program was designed to focus on the introductory courses of biology, chemistry, and computer-science majors (Huebner, 2009). One key component that all successful programs shared was an increased level of mentoring and contact with peers and faculty in the discipline of interest.

### 2.2 Mentoring as a tool for retention

Learning communities have become more prevalent in colleges and universities to help develop a mentoring system for students. The learning communities support students who share a common career path by discussing issues and topics related to their field. There are now more than 600 campuses which offer mentoring support for students pursuing a STEM major. One program that specifically supports female students in the STEM disciplines is the Women in Science and Engineering program, (WISE). This program provides an outlet for females to discuss and motivate each other within the STEM disciplines. It is noted that, “improved mentoring of women can have significant effect on their careers and lives, and on the academic climate and structure more generally.”

Results showed that retention rates from first- to second year for WISE students were higher than those for all first-year students 93.6% versus 82% (Pace, Witucki, & Blumreich, 2008).

A longitudinal study by Seymour and Hewitt (1997) revealed that poor advising is cited as a major factor in the decision to abandon science, mathematics, and engineering majors by a full 75% of students. Study groups were also found to be of key importance for learning the material and counteracting the feeling of isolation throughout the STEM areas. Faculty in the sciences need to provide support and encouragement for students, especially in the beginning years of college. The course material in introductory courses has been questioned in regards to the challenging content expectation levels for freshman and sophomores. Mentoring students in the STEM disciplines have found to cause both positive and negative experiences for students. A positive experience from a mentor can help keep the student interested in the science areas and negative experiences can deter them.

One method of mentoring students in the STEM areas at the college level was to investigate the impact of teaching assistants (TA's) on undergraduate students. A study conducted by O'Neal, Wright, Cook, Perorazio, and Purkiss (2007), found lab climate to be a significant factor for students. The STEM participants from the study indicated that a TA's efforts to make the lab atmosphere positive, enhanced their learning process and motivated them to stay in the science majors. Overall the study found having a positive experience with TA's can impact the long term retention and interest of students.

### *2.3 The SETGO program*

The SETGO program includes a three-tier approach to retention of undergraduate STEM students. First, a summer bridge program, called the Owens Ready Bridge, ORB, is held at a near-by Community College in order to prepare entering freshmen or transfer students for the rigors of academic study as well as to provide a networking environment for support during their transition. During the 5-week program students joined a supportive, small group (6 students/ instructor) for hands-on, integrated laboratory and classroom instruction for 10 hours each week. The bridge curriculum highlights the interconnection between the physical and natural sciences, and how mathematics supports scientific inquiry.

Second, once students have completed their first year of study and have maintained a GPA of 3.0 they are eligible for a paid internship, called the SETGO Summer Research (SSR) working one-on-one with a faculty member in the STEM field of their interest. This is a 10-week intensive immersion into the laboratory setting and the undergraduates are expected to conduct their own research investigation, with support from their mentors. SSR students also join informal weekly forums in which scientists inside and outside of academia discuss the latest advances in their own research, and making informed career choices - explore mentoring issues, career opportunities in STEM fields, pathways to graduate school, and how to balance work and family responsibilities. The summer experience is capped by a mini-symposium at which participants present a poster on their research project.

Third, in order to bring these two programs together as well as support both groups throughout the academic year, SETGO also hosts a learning community called the Arts of Science Learning Community, ASC. These regular meetings feature a guest speaker and rich opportunities to connect with mentors, educators, and colleagues in the Midwest. With a common theme 'Building a Better Environment', the ASC highlights the social relevance of science and the diverse research strengths of faculty sponsors, from the design of semiconductors and biosensors, to the impact of anthropogenic chemicals on ecosystem health. The goal of the ASC is for students to interact with mentors, broaden their background in science, meet successful practicing scientists, increase comfort levels in professional situations, and maintain momentum to graduation.

## *3. Research Design and Instruments*

The SETGO program was a five-year program funded by the National Science Foundation. We are now in our fifth and final year of this program. Thus far we have had more than 90 high school or community college students participate in the Owens Ready Bridge (ORB) Summer Institute. In addition, there have been 160 undergraduate participants in the SETGO Summer Research Experience (SSR). This number includes more than 20 students who first participated in the ORB. There have been more than 50 faculty mentors from more than 15 STEM disciplines.

The overall evaluation of the SETGO program was extensive and involved a combination of quantitative and qualitative research methods. To effectively understand the impact of this program, both quantitative and qualitative data sources and analysis techniques were used.

For the purposes of determining how mentoring impacted attitudes and retention, we draw primarily on three main data sources to aid in triangulation of our themes: The Science Attitude Survey, observations of the program, and individual interviews.

### 3.1 The Science Attitude Survey

The Science Attitude Survey is derived from several attitude and belief surveys (Bandura, 1990; Choi, 2001). The intent of the survey was to determine initial attitudes, behaviors and beliefs that might led to academic success and retention. The survey was given pre and post to both ORB and SSR students. The survey has 12 Likert-scale response questions including questions about study habits, beliefs about their abilities to succeed in the STEM disciplines, and their views of how others in their lives support or do not support their decisions to pursue a STEM degree.

### 3.2 Program Observations

Two separate components, the Owens Ready Bridge (ORB) and SETGO Summer Research (SSR), ran simultaneously over the summer. In order to effectively evaluate the program observations were conducted by the SETGO assessment team throughout the duration of these components. First, two sections of the ORB meet three days a week for five weeks, one in the morning and one in the afternoon. An observer was present for either the morning or afternoon session of each of the classes or field trips. The SSR program had a common meeting time every Wednesday, at which a member of the SETGO mentor facilitated and an evaluator took field notes. In addition, each of the student participants were visited in their lab setting.

### 3.3 Interviews

All of the ORB and SSR students and faculty participated in structured individual interviews at the end of each academic year (Fontana & Frey, 2000). The interview consisted of 12 structured interview questions and was run by the project internal evaluator or one of the evaluator's graduate assistants. The same protocol was used for both the ORB and SSR participants and faculty, although the questions were specific to the particular program component. The interviews were tape-recorded, transcribed, and coded.

## *4. Data Analysis*

The interview responses of the ORB, SSR, and faculty mentors, as well as the field observations were analyzed using a grounded theory perspective (Charmaz, 2000; Erickson, 1986; Glaser & Strauss, 1967). To identify emergent themes and assess the use of reflective thinking within the data, two readers of the research team independently reviewed all of the interview data and field observations. From iterative readings of the journal prompts and evidence, initial codes were subsumed under broad categories (Erickson, 1986). For example, each of the research members noted several themes throughout the surveys, interviews and observations. These themes included big ideas such as mentoring, past experiences in science or mathematics, and future goals. The focus of this paper is from the theme of mentoring. After discussing these specific themes and the examples that both agreed on, the group determined "sub themes" or specific codes and their associated definitions (Glaser & Strauss, 1967). For instance, "influence of graduate student experiences," was decided on as a sub-theme under mentoring. The assessment team agreed that there was a breadth of respondents who reported they recognized the importance of discussions and experiences with graduate students in the laboratory. The theme of mentoring is the umbrella for each of these important ideas.

The research team then revisited the data and recoded with these categories or codes in mind (Erikson, 1986). These categories were used in further iterations of data readings by the researchers, who met to negotiate and clarify the themes and their meanings. Once this was accomplished, data that fit each of the themes were coded with that category and later used to elaborate on findings in this study. The research team agreed that in order to establish "fit" all three readers had to agree that the data met the operational definition. Miles & Huberman (1994), refer to this as "an organized assembly of information that permits conclusion drawing and action taking" (p. 11). By using the grounded perspective the researchers were able to triangulate meaning from multiple sources, (interview, observation, and survey) so that we were able to "accurately describe what [we] understood, constructing recognizable reality for the people who have participated in the study" (Maykut & Morehouse, 1994, p. 122). The findings and conclusions, drawn from the categories, will be explained in subsequent sections.

## *5. Findings*

Several important themes were evident in the survey, interviews, and classroom observation. These themes detail the importance of establishing mentoring relationships with peers, graduate students, and faculty members. Mentoring is a key factor for both faculty and students, in all three of the SETGO activities. Students from the ORB and the SSR were both invited to participate in the ASC with their faculty mentors. The ASC is used as an umbrella program to bridge the two other programs and to bring all of the SETGO scholars together for social and academic purposes. However, results from each of the programs will be discussed individually in order to understand how each of the programs impacts the students who participate in them.

### 5.1 The ASC Academic Year meetings.

There were six Art of Science (ASC) meetings each year of the SETGO program. The overall goal was to establish fellowship interdepartmentally, provide mentoring, and to participate in learning about current and interdisciplinary research. The data revealed that the program did an excellent job of providing a space for mentoring and a wide variety of guest speakers. Generally, the ASC meetings are well attended by those students directly participating in ORB or SSR and corresponding faculty members. Moreover, evidence of emergent interest amongst regional colleges is particularly encouraging, suggesting that the collaboration with OCC reflects a broader potential for establishing partnerships and mirror sites of SETGO.

**5.1.1 Mentoring.** Both faculty and undergraduates described mentoring at the ASC meetings as an introduction to the profession. Attending lectures and keeping current on research and ideas is an important part of the academy and faculty felt it was their responsibility to model this for undergraduates. Many of the faculty believed that undergraduate programs do not adequately present the realities or interest of research, therefore, does not provide an avenue of interest for undergraduates. For instance one faculty member commented "I have always been concerned that my undergraduate students don't understand the value of getting research experience as part of their bachelor degree program. I have invited students to attend with me so they can see the practical applications of research and understand the importance of continuing their education with a Masters or Ph.D. (Dr. Peters[1])." Having a one-on-one connection with undergraduates is one way to ensure retention. Also, when faculty began mentoring early, students and faculty agreed that students were more likely to approach them if there were problems. Dr. Broke suggested "A lot of time and energy goes into training an undergraduate to work in your lab. If we can begin to work with them early, even the summer after their freshmen year, you have the potential to have them in your lab for two or three years. Everyone benefits, you have a consistent well-trained student working in your lab, and they have the experience and a knowledgeable source to come to for questions and concerns. You build a family away from home in your lab". For these reasons faculty were eager to participate in the ASC meetings throughout the academic year.

Students also recognized the impact that the ASC meetings had on their undergraduate experience. A SSR student commented, "This is a great way to meet faculty outside of the classroom. It is important for them to get to know you as a person as well as a student, especially if you want to work with them in the future" (Sarah). In addition students commented on the importance of understanding the career path. The guest speakers were encouraged to provide a little background about their educational experiences and reasons for pursuing a STEM degree. Dr. Stepien was an engaging speaker who discussed her unique pathway to working as researcher and Director of the Lake Erie Center. She used real life examples to share how mentoring helped her make important career decisions and research experiences that allowed her to become a successful researcher today.

**5.1.2 Interdisciplinary research.** One of the goals of the ASC meetings is to make sure that the guest speaker and discussions apply to a wide variety of interests and disciplines to help students understand the range of options a STEM degree can offer. For example, Dr. Semrock described how he and his wife designed and co-built "Solterra" an earth-sheltered, passive solar home with seven alternative energy sources. His presentation was an excellent representation of how science and math are interrelated. His presentation helped to open the eyes of students and faculty to the possibility of not just one, but multiple types of green energy sources working together to increase efficiency. Dr. Semrocks' talk was engaging, as it provided not only information about the uses of alternative energies, but he took the participants step-by-step through the design and construction of Solterra as well.

[1] All names have been changed to protect confidentiality.

Many of the students and faculty were impressed by the shear number of man hours, (and loads of concrete), that were required to create this unique structure.

Several of the participants commented on the importance of an interdisciplinary approach to the ASC meetings. For instance, a SSR student wrote "I have always been interested in alternative energy, but I always thought of them as separate things, (wind, solar, geothermal). I was amazed to see how they could all be used together to essentially eliminate the need to be on the grid. It has completely changed the way I think about my major and has motivated me to continue to think about these types of integrations" (Matthew). An ORB student commented on her realization that her interests could be a career. "I appreciated one of the meetings being held at the Community College, it made it easier for me to participate. I feel I learned a lot about how I can turn an interest in alternative energy into a career building alternative energy engines. I am really excited about this possibility" (Jackson). Both students clearly identified a specific way that the speaker was able to motivate and provide a specific STEM pathway for that interest.

**5.2 The Owens Ready Bridge (ORB)**

The ORB was purposely designed to increase content knowledge and retention based on the successes of other BGSU bridge programs (Gilmer, 2007). Over five years, more than 90 students participated in interdisciplinary lessons including mathematics, biology, chemistry and ecology. They spent approximately 10 hours a week in class with four different faculty members engaged in interdisciplinary laboratory and field work. In addition, two peer facilitators from the partner university were present to assist as mentors and also to provide a peer connection to the university. The main focus of the ORB was to help students who were interested in STEM disciplines build a solid foundation in mathematics, as well as gain a better understanding of core interdisciplinary topics in the sciences. As a result of the coding of observations and interviews, three main themes were relevant to this paper; learning experiences, mentoring experiences, and future goals.

**5.2.1** ***Learning experiences.*** The ORB was designed with two sections so that ratio of participants to faculty could be lower (1:12) and for field experiences. For instance, ORB students had the opportunity to take weekly field trips to a nearby watershed to collect soil, water, and insect samples that were used in laboratory work back on campus. The instructor and peer facilitators took time to work on-on-one with students and with small groups and a great deal of teaching took place during these conversations. ORB students noted "The small classes allowed you to have a more personal relationship with the faculty teaching the course, they were more like a mentor than a teacher. I was a more comfortable asking question when I didn't understand something. Also, I was more involved in the laboratory experiments because the groups were so small" (Todd). These personal relationships and teaching moments are cited by students as key to their interest and successes.

The small group learning environment, as well as the activities students participated impacted their enjoyment and interest. For example, the students also had the opportunity to conduct Polymerase Chain Reactions and to learn more about DNA sequencing. The students were intent on their task, you could almost hear a pin drop they were so involved in getting the drops just right on the PCR. The ORB students were getting an opportunity to learn techniques that they would not normally get until upper level content courses. However, they were engaged and motivated to understand the science behind their work. These experiences helped students to gain confidence in ways that regular classroom work had not in the past. "I was never really all that confident in math before this and now I know I can do it if I actually try. Be more patient than before, so it really does help…. I really like the ecology topics because it was a chance to go out go to places I haven't really been to before. It was fun and hands-on you got to tests and experiments you wouldn't normally do in science classes" (Brad).

**5.2.2** ***Mentoring experiences.*** Mentoring by the faculty and the peer mentors also had a significant impact on students participating in the ORB. Participants stated that they gained a greater confidence doing science and mathematics. For instance, Jennifer said, "I was never really good at science or math in high school, but I really love animals, so I know I need to learn more about both if I want to pursue a degree working with animals. The teachers here were more like mentors, I felt like I could ask the questions I have never been able to ask before. For the first time, I like science and I feel like I could do well in other science courses". Another student claimed, "Because I got to know [instructor] I now feel like I have someone that I could email if I had questions about content or about my career. It is like having your own personal advisor or mentor. I am so glad that I participated because it makes completing my degree seem possible" (Stacey). This link with faculty was a common reason for interest and confidence stated by the students.

The peer mentors also had an impact on the ORB students. Almost all of the ORB students found the peer facilitators to be helpful and necessary in the course. "I was glad that Laura was here to help me, I now know someone at the university that I can call to get advice on classes and instructors to take there! That makes me feel more confident about my move to BGSU" (Larry). The peer facilitators also supported the undergraduates' assessments. They described their role as facilitator, a person to answer questions, or to assist in laboratory set-up and data collection. "There were many times when students were on the right track, they just lacked the confidence to move ahead without the instructors go ahead. I felt I was able to encourage and support, helping to build confidence" (Laura- peer facilitator). The peer facilitators have also reported being contacted for information during the academic year by several of the bridge students. "I remember I was walking across campus last week and I was stopped by a ORB student with a question about which faculty member they should choose for course registration" (Betsy- peer facilitator). Answering a question like this may seem trivial, but it is just this type of support that encourages, motivates and facilitates retention.

***5.2.3 Retention.*** A primary goal of the ORB bridge is to encourage graduation from the Community College in a STEM field, a secondary goal is to encourage transfer to a four-year college to pursue STEM degrees. The ORB students were asked what their future goals were, both short and long-term. More than a third of the students planned to graduate first from Owens Community College and then transfer. "I have two semesters left here at OCC. Once I finish here I plan to transfer to BGSU to get my masters in Biology, well, that is my final goal, to get a masters, but I will get my Bachelors in Biology first" (Mandy). While, the other half planned to go directly to a four-year institution or take a few more classes at OCC and then transfer to BGSU or another four-year institution. "This year I will be graduating with my associates and I will be transferring possibly to BG because this course helped my push towards that" (Todd). All of the students felt they were prepared to reach their goals, and the concerns that they did have revolved mainly around the ability to pay for their education, rather than their ability to succeed. Table 1., documents the confidence gains these students have made as a result of participation in the ORB. Notice that these students are more confident in their abilities to be successful in a technical career than to complete the necessary math and science courses necessary for these jobs. There was an increase in confidence across the board after participation in the ORB. Specifically, students are significantly more confident in the math and chemistry requirements after they were immersed in this content during the ORB.

***5. 3 The SETGO Summer Research (SSR)***

Over the past five years there have been more than 160 students and 80 mentors who have participated in the SSR program. SSR students had ten weeks to complete their summer research study. The SSR program began with a day-long introduction to peers and mentors, as well as a program designed to establish understanding of expectations and individual roles in the summer research experience. As was found with the ORB, mentoring and confidence were also common themes found in the data.

**5.3.1 Mentoring.** Mentoring for the SSR was critical for student success. All of the SSR students reported success in working with their mentors. Many cited weekly meetings, one-on-one training, and practice in critical thinking as the keys their relationships with their mentors. For example, "I learned to value good communication skills this summer. My mentor and I met once a week, but we found the daily log that we each kept to be critical to be able to keep moving forward if one of us was not in the lab. I definitely learned how important it was to keep good notes about my progress" (Tara). Another student said, "I felt like she was always around, which was great for me. I felt like I knew nothing when I first started and I was so afraid to make a mistake. Her confidence in me helped me to grow and to learn to take risks. It was an awesome learning experience, I just wish it was longer" (Sharon). These comments are typical of what the students and mentors reported in exit interviews.

The faculty mentors shared their perspective about the impact of mentoring. One faculty member commented "the SETGO program provides the students opportunities to work with science in a hands-on way and to see how scientists work in real life situations. The mentors help motivate undergrad students to continue in the science or STEM career pathway" (Dr. Smith). The mentors listed several ways in which they motivate undergraduates; reduce the intimidation factor, helping to make the "textbook" come to life in the laboratory, providing personal one-on-one advice and support, and increase enthusiasm for the discipline. These factors were key in motivating faculty to participate in the SETGO program. Specifically, Dr. Hudson stated "Involving students in hands-on science experiences really gets them more involved which increases their enthusiasm so they can stay with us.

So I think the goal of the mentor is to facilitate that part of it, really show students how much fun science really is and how to do it right". Faculty mentors personally believe that their time and energy will result in more dedicated and interested STEM students.

In addition to excellent working relationships with their faculty mentors, many of the undergraduates reported additional benefits from working with graduate students also working in the lab at the same time. The undergraduates sometimes, especially in the beginning felt more comfortable asking the graduate students questions (similar to the peer mentors from the ORB). "I worked with the grad students and they taught me how to use the media and auto plates, I learned how to do what they are doing. They showed me all about the Electron microscopes for the portfolio, they answered a lot of my questions (Lisa)." Other students said they learned a great deal about other opportunities and research projects from listening to the weekly reports given at lab meetings, the weekly seminars and the ASC meetings. " I think the opportunity to engage with a lot of different people as far as professors, graduate students, and mentors in math and science have been extremely helpful. Not just my own mentors but through the different Arts and Science community activities, I have really enjoyed that and gained a great deal of knowledge (Julie). The impact of other graduate students was not planned for in the original design, however, it now appears that this level of mentoring is also important and will be considered in the next round of applications for summer research projects.

**5.3.2 Increase in confidence.** Students reported a significant confidence gain, particularly in the research process. Many of the students commented that their undergraduate classes did not prepare them for the rigors or even the processes of designing a research study. "I thought I knew what it meant to design a research study, I understood the scientific method after all. I had no idea so much was involved, especially the review board, the research reading, and the variable control. Every student should have an experience like this so they can appreciate the rigor of research" (Bud). Being unprepared for the rigors of graduate research is one reason that students are not successful. Providing undergraduates with the opportunity to gain some insight will help them better prepare for graduate education. Another student summed up her confidence gains by saying "I now feel like I could do this again on my own. I never thought that would be possible just after 10 weeks" (Bess). Finally, "I finally understand why I need to know what I am learning in class and how it applies to the real world. If I only knew this when I was taking microbiology class, I would have studied harder, I will in the future" (Justin). These positive comments correlate to the positive dispositions these undergraduates have for having the abilities to pursue their degrees in STEM related fields. This directly relates to the confidence levels of these undergraduates to perform well in their majors and to pursue a STEM career.

Table 2 shows that there were minor gains from these students, but these gains were not as significant as those found in the ORB above. Students who pursue summer research tend to be more confident and sure of their pathway than those just learning about their options. In addition, a 3.0 GPA requirement was in place for the SSR students, which means that students who are participating are typically already doing well academically. These results do show a gain in confidence completing the chemistry requirements as well as a slight gain in the mathematics requirements. Most of the students remain confident about their goal to pursue a career in the sciences and expect to do well.

## *6. Conclusions*

The SETGO programs and specifically, the mentoring have positively impacted STEM students to further their education and in most cases continue on to a four-year college or graduate school. The Owens Ready Bridge impacted the motivation and confidence levels of the participating students. The ORB students stated they are more likely to do well as a result of the review and immersion in the content that they experienced. They also cited faculty and peer mentoring, as well as small class sizes as a motivating factor for their successes. Several of the participants have already transferred to a four-year institution in a STEM discipline, and others intend to do so upon graduation from Owens. Preparing students early for the rigors of STEM academic work is one way to increase retention and to motivate students to pursue STEM degrees.

Likewise, the SETGO Summer Research program also facilitated a direct mentoring experience for those students more certain of a STEM degree. They were able to gain valuable experience working in a laboratory setting to better understand the value of graduate education, as well as the rigors of such a career path.

The unique opportunities to work on a self-designed research project not only motivated, but also helped to build confidence in many SSR students that they felt they were lacking before this experience.

As faculty stated, this is a unique opportunity to mentor and to help students develop a life-long passion for a STEM career.

Finally, the Arts of Science Learning Community is an academic year way to sustain these mentoring relationships and to build new ones. The ASC helps to facilitate social bonds across disciplines while at the same time allowing for wide exposure to a variety of STEM career possibilities. At this point the ASC meetings are meeting their purposes and providing an avenue for both programs to meet and mingle and learn from one another.

These programs will not, by themselves, reduce attrition from STEM careers as there are many reasons for this loss. However, by providing a motivating and engaging experience, with faculty mentoring, students will be more likely to persist and continue to pursue their dreams in the sciences. More programs such as these are needed to help reduce attrition from the STEM disciplines.

**Table 2: ORB Confidence Pre/Post Data**

| How confident are you that you can do the following: | Strongly Agree | | Agree | | Disagree | | Strongly Disagree | |
|---|---|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| Complete the mathematics requirements | 25% | 45% | 50% | 30% | 30% | 25% | 0% | 0% |
| Complete the chemistry requirements | 15% | 40% | 40% | 30% | 50% | 30% | 0% | 0% |
| Complete the Biology requirements | 35% | 45% | 55% | 45% | 15% | 5% | 0% | 0% |
| Perform well in a technical, scientific career | 40% | 50% | 35% | 40% | 25% | 10% | 0% | 0% |
| Remain in the sciences over the next year | 60% | 65% | 30% | 25% | 10% | 10% | 0% | 0% |
| Remain in the sciences over the next 2 years | 60% | 65% | 25% | 25% | 25% | 10% | 0% | 0% |
| Excel in the sciences over the next 2 years | 40% | 50% | 35% | 40% | 25% | 10% | 0% | 0% |

**Table 2: SSR Confidence Pre/Post Data**

| How confident are you that you can do the following: | Strongly Agree | | Agree | | Disagree | | Strongly Disagree | |
|---|---|---|---|---|---|---|---|---|
| | PRE | POST | PRE | POST | PRE | POST | PRE | POST |
| Complete the mathematics requirements | 78% | 80% | 19% | 20% | 3% | 0% | 0% | 0% |
| Complete the chemistry requirements | 49% | 73% | 22% | 5% | 27% | 22% | 2% | 0% |
| Complete the Biology requirements | 75% | 79% | 19% | 21% | 5% | 0% | 1% | 0% |
| Perform well in a technical, scientific career | 68% | 72% | 24% | 24% | 7% | 4% | 0% | 1% |
| Remain in the sciences over the next year | 86% | 89% | 14% | 10% | 0% | 1% | 0% | 0% |
| Remain in the sciences over the next 2 years | 86% | 89% | 14% | 10% | 0% | 1% | 0% | 0% |
| Excel in the sciences over the next 2 years | 84% | 84% | 16% | 15% | 0% | 1% | 0% | 0% |

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