Increasing STEM Enrollment Using Targeted Scholarships and an Interdisciplinary Seminar for First- and Second-Year College Students

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Abstract

To attract and retain more academically qualified students to science and mathematics, we developed a merit-based scholarship program for incoming students with STEM interests. Scholarship recipients participate for the first two years in an interdisciplinary learning community and declare a STEM major by the sophomore year. STEM Learning Community (SLC), a year-long course initiated in fall 2009, has become a permanent part of the College curriculum. Content consists of weekly meetings for discussions and presentations on such topics as scientific ethics, relationships between science and technology, the nature and history of science, and the interplay between scientific discovery and societal development. A major component are group research projects conducted during the school year and presented at our annual undergraduate research symposium. In addition, we provide career counseling, visits and presentations by STEM professionals, and internship opportunities. Students report that they are developing such valuable skills as problem solving ability, communication skills, collaboration, and knowledge of the research process. Enrollment and graduation data show that numbers of participants, especially women and minority students, increased following the inception of the SLC. The results suggest that targeted scholarships combined with engagement in collaborative undergraduate research are a useful tool for enhancing STEM recruitment and persistence.

Introduction and Rationale

Attracting more students into STEM fields is a national priority (Jackson, 2003). The global economy increasingly requires persons with scientific, engineering, and technological skills. The US can remain a leader in science and engineering only with a well-educated and effectively trained population. Unfortunately, the US lags behind other industrialized and industrializing nations in percentages or total numbers of undergraduates receiving degrees in natural sciences, engineering, computer science, and information technology (Committee on Prospering, 2007).

Fortunately, there is a consistently high level of US student interest in undergraduate STEM programs, with about 50% of pre-college students indicating an intention to major in a STEM discipline (Committee on Prospering, 2007; ACT, 2014). There is a large gap, however, between the stated intentions of incoming students and their persistence to successful degree completion with a STEM major. In fact, undergraduate STEM programs tend to display the lowest persistence rates among all academic disciplines despite evidence that students who drop out of STEM programs are as qualified as, if not more qualified than, college entrants as a whole (Seymour and Hewitt, 1997).

The first year of college is a particularly risky time during which many students entering with an interest in science or mathematics switch to a major outside the STEM disciplines (Astin and Astin, 1993; Seymour and Hewitt, 1997; Daempfle, 2003-2004; Committee on Prospering, 2007; Graham et al., 2013). This attrition rate may be as high as 60% overall, and even higher for women and minorities (President's Council of Advisors, 2012). Persistence is reinforced by academic success, however. Risk of attrition from the sciences declines the longer a student remains in college.

Furthermore, historically underrepresented minority groups, which constitute about 25% of the US population and 17.9% of undergraduate students, make up only 2.5% of students in STEM majors and 6% of the entire US science and engineering workforce (Committee on Prospering, 2007). And, although women make up nearly half of the entire US workforce, only a quarter of the science and engineering workforce consists of women (National Science Board, 2004).

Demographers forecast that 42 % of the US population will be composed of African Americans and Hispanics by 2050 (Passel and Cohn, 2008). This demographic shift means that racial and ethnic minority students will necessarily constitute an increasingly larger percentage of students in the potential STEM talent pool.

Our strategy to increase STEM matriculants through scholarships

To increase the number of STEM matriculants at the college, in 2000 we began a program to offer four-year competitive scholarships to students pursuing a bachelor's degree in a STEM discipline. The focus has been on several STEM departments at the College—Biology, Chemistry/Physics, Mathematics/Computer Science, and Psychology—that have worked together closely for many years and constitute the main portion of the College's Division of Science and Mathematics. The principal goals of this program are to improve recruitment and persistence of students in STEM fields at Bethel College and to prepare these students for diverse careers in research, practice, and industry. In 2008, we secured a four-year S-STEM grant from the National Science Foundation to augment our existing STEM scholarship program and attendant activities. During the S-STEM funding period, we worked diligently with the College development office to build an endowment to sustain the scholarship program in perpetuity. All scholarship recipients are expected to maintain a specified standard of academic excellence in their college coursework and make reasonable progress in a STEM program of study to retain eligibility. We are persuaded that such a scholarship program, combined with the appropriate student support services, is also an effective means to increase STEM participation by underrepresented minorities and women. In 2006, prior to the initiatives begun under the S-STEM grant, Bethel College's rates of minority and women STEM graduates were 9% and 33%, respectively, and we hoped to improve these percentages.

Strategies to improve STEM persistence

Persistence in the sciences improves where programs employ cooperative learning strategies to develop peer support or where students are encouraged to participate in research with faculty (Seymour and Hewitt, 1997). Nurturing environments are strong predictors of student persistence in STEM majors, particularly for women and minorities. Such a climate is created through regular contact with faculty, social gatherings with faculty and peers, seminars and discussion groups, support networks, and mentoring experiences.

A key factor for retaining students in STEM majors is assuring that students feel connected to the intellectual and social life of the college (Tinto, 1993; Braxton, 2000). STEM-related extracurricular activities and interactions

with established scientists, applied mathematicians, and engineers can be powerful motivating forces for students (Committee for Prospering, 2007) and better prepare them for the STEM workforce (Martincic and Carlson, 2003).

Minority and women students have particular support needs (e.g., higher levels of personal attention in the forms of peer mentoring and tutoring; BEST, 2004). Providing these students with opportunities to develop relationships builds support within the cohort group while fostering allegiance to the college, the department, the discipline, and the profession. Our goals to enable students from underrepresented groups to succeed and expand their representation in STEM majors include some additional efforts. We seek for them enriched research experiences that provide hands-on opportunities beyond the classroom and connect learning to the world of work. The various STEM departments provide numerous opportunities where students can assume responsibilities as researchers, peer-mentors, and instructional assistants, and inquiry-based experiences where students engage jointly in efforts that infuse education with the excitement of discovery. Internships and other connections build bridges to STEM professions after college.

The project, with major additional funding through the S-STEM grant, comprises a set of integrated activities designed to enhance undergraduate recruitment and persistence of STEM majors, and encourage successful placement following college in a job or post-college preparation. Thus, this program has three primary interrelated objectives:

- Attract more students into STEM programs, especially students from historically underrepresented groups (women, minorities, family financial need, first generation college)
- Improve persistence to graduation by forming a cohesive learning community among STEM students and providing academic support services and opportunities for STEM-related activities outside the classroom
- Provide bridges to careers and graduate programs in STEM areas

Recruitment to STEM

Small, independent colleges, of which Bethel is typical, graduate a much smaller absolute number of students than do large universities, but a relatively large percentage of their graduates pursue and complete PhDs in the sciences, producing a disproportionately large share of PhD scientists (Ekman, 2006). Thus, liberal arts colleges are important contributors to the science and technology workforce.

We actively recruit STEM students and promote our science scholarships via the Bethel College web site (www.bethelks.edu), regular activities of the Admissions Office, campus visits by prospective students and interviews with STEM faculty, and our annual Summer Science Institute for high school students (a June event that features hands-on programs in biology, chemistry, computer science, mathematics, neuroscience, and psychology).

Students offered a STEM scholarship to study at Bethel College are a select group. The program awards scholarships to students who meet certain academic criteria (generally, an ACT score of 24 or higher and a high school GPA of 3.7 (on a 4-point scale) and above) and who express a strong interest in a STEM major. Students eligible for these awards are identified by Admissions personnel, who then schedule an on-campus interview with two STEM faculty members. Decisions about scholarship awards are made by consensus among the STEM faculty. STEM scholarships are annually renewable for four years, provided students maintain a 3.0 college GPA (on a 4-point scale) and continue to make reasonable progress within a STEM major.

STEM Learning Community course

Once STEM students have been recruited to the college, our second objective is to improve persistence to graduation by forming scholarship students into a cohesive learning community and providing attendant support services. Our goal to incorporate students with STEM interests early on and to sustain them via a cohesive learning community includes an orientation at the very beginning of their college career, a learning community to provide collegiality and develop research skills, academic and career services to advance them toward their long-term goals, and programming to facilitate a smooth transition to a STEM major (Graham et al., 2013).

STEM Learning Community (SLC) is a requirement for all freshman and sophomore recipients of a science or mathematics scholarship, and strongly recommended for others with these interests. In this course students explore scholarly inquiry through readings in the history, philosophy, and ethics of science; web-based conferences; observation and critique of senior thesis projects; presentations on STEM careers and internships; and designing and completing a collaborative research project.

Orientation for new STEM students

Although for many years we hosted an informal reception to welcome new STEM students, in 2009 we developed an orientation program for each new cohort of science and math scholars that is more formal and extensive than what had occurred previously. The orientation begins with a noon meal that brings together STEM faculty, the new students, and their parents (if present). A typical schedule for the rest of the day includes of general introductions of new students and STEM faculty, presentations by faculty on the research opportunities available in their labs, career information, brief presentations by current STEM students, and tours of labs. Additional group activities are designed to introduce students to the practice of science and to one another. These orientation sessions constitute the first class meetings of the STEM Learning Community.

Interdisciplinary scope

Careers in STEM fields are becoming increasingly interdisciplinary in scope. Today's STEM students need a broadly based core curriculum together with an interdisciplinary seminar and adequate foundations in the life and physical sciences as well as in mathematics (National Research Council, 2003). Moreover, the sciences are not separable from other areas of life. Hence, interdisciplinary STEM seminars enhance student learning by demonstrating the relationships among the sciences, mathematics, social sciences, humanities, and arts (Daempfle, 2003-2004). Fortunately, effective pedagogies for enhancing student learning outcomes are not discipline-specific (Kuh et al., 2005, 2007; Pascarella and Terenzini, 2005). For example, problem-based learning that utilizes diverse research teams (diverse in terms of intended majors, year in college, ethnicity/race/gender) is both active and collaborative and helps develop many of the skills (flexibility, collaboration, intrinsic motivation) essential to form well-educated 21st century citizens (Michaelson et al., 2002; National Research Council, 2010; Kober, 2015).

Forming a cohesive learning community

An important aspect of the STEM scholarship program is required participation in an interdisciplinary seminar with peers and faculty beginning in the student's first year. The new course, STEM Learning Community (SLC), was developed by the authors with support from the NSF S-STEM grant and was added to the College's permanent curriculum in 2009. In this course, beginning STEM scholars are formed into cohorts that are managed and supported as active learning communities. Such participation fosters a sense of academic community, builds ties to the STEM disciplines, integrates lower-level students with their upper-level counterparts, and provides a support network that encourages ongoing academic success while informing students about career opportunities in STEM fields. The seminar engages students in multiple activities to develop significant relationships with faculty while building and enhancing a cohesive learning community with their peers. Activities are designed to increase excitement in the sciences and awareness about STEM fields, thereby improving the likelihood that students will pursue a STEM-related career after graduation.

Since our scholarship students represent several academic departments, and are pursuing different programs of study, it is important to create events at which students can associate together naturally. To facilitate such interaction, and help integrate STEM students into the life of the college, we schedule special speakers, field trips, receptions, and other common activities. Professional preparation is aided by laboratory or departmental

assistantships, summer research projects, presentations by invited speakers, and off-campus internships. Course content consists of attendance at STEM departmental seminar presentations including an annual fall STEM Symposium, guided readings on the history and practice of science, career information and exploration, a faculty-advised group research project that proceeds throughout the entire year, and other team-building and celebratory activities. The goal is to provide a focused, unified, integrative experience for STEM scholarship students that emphasizes career and personal counseling, academic assistance, peer-mentoring, and opportunities for research experiences and internships.

The STEM Learning Community seminar, the "flagship" of the program, includes these elements:

- group discussions and group presentations on such topics as scientific ethics, classic papers, the nature of scientific inquiry, relationships between science and technology, the nature and history of science, the interplay between scientific discovery and societal development, and concepts that unify the various STEM disciplines
- collaborative group research projects conducted during the school year and presented at the annual Undergraduate Research, Internships and Creative Activity (URICA) symposium
- regular attendance at one of the existing junior/senior seminars to hear presentations by faculty, invited speakers, and graduating students
- visits, presentations, and consultations with individuals working in STEM fields; career panels
- common meals and other social and celebrative gatherings

With time, we broadened the array of experiences in the SLC class sessions by providing additional and more varied career sessions, student presentations on the history and ethics of science, web-based content on global climate change, renewable energy technologies, energy accounting, and the group research projects on wider topics, faculty-led small group discussions on scientific ethics, and web-based conferences. At the same time, we included a greater variety of invited speakers and increased the emphasis on STEM internships.

Because of the obvious benefits to all STEM students provided by this course, SLC is a requirement for all science and math scholarship recipients, and encouraged for any new student with a strong interest in STEM. The course is graded pass/fail, and students receive 0.5 hour of college credit per semester for their completion of assignments. Typically, students enroll in the course for four semesters until transitioning to the appropriate junior seminar course in their major. It is expected that SLC students formally declare a STEM major within the first or second year in college.

Students engage in several types of STEM-related learning experiences beyond the classroom from the freshman through senior years. Some of these activities (orientation, seminar) are required of all STEM scholarship awardees; others (departmental employment, internships) are encouraged but not mandatory. Academic counseling is available as needed.

Research experiences

The process of scientific inquiry is key to excellent education in the sciences; conducting active research enables the student to contribute directly to the discovery of new knowledge. Even students who are preparing primarily for professional schools or clinical careers can benefit from research experiences (Trask and Francom, 2009; Shanahan et al., 2015). There is persuasive evidence that undergraduate research helps prepare students for scientific careers, provides a context for active learning, stimulates excitement for STEM learning, and encourages persistence in a STEM career path (Hunter et al., 2006; Lopatto, 2007; Russell et al., 2007). Student preconceptions of science laboratories as stern and uninviting can be counteracted by research experiences (Adedokun and Burgess, 2011; Graham et al., 2013). For these reasons, the National Research Council (2003) recommended that students be given the opportunity to pursue independent research as early as possible. Involvement in a research project allows the student to acquire quantitative skills, perform and interpret statistical tests, and present data graphically, thereby accelerating the mastery of key concepts. Strong undergraduate research experiences provide students with critical thinking and evaluation skills. Communicating the excitement of research is crucial for attracting and retaining STEM students.

The importance of undergraduate research engagement at Bethel is demonstrated by the senior thesis that has been required of all STEM graduates for decades. For the great majority of STEM students, this requirement is fulfilled by designing and conducting an empirical investigation which is reported in a substantial paper, including an extensive review of the literature. For nearly 70 years, an independent research project, conducted on- or off-campus but with the guidance of a Bethel faculty member, has been a graduation requirement for all science majors. Even prior to the senior thesis work, research projects are encouraged by summer grants offered by the college or by faculty members with extramural funding. Competitive summer fellowships are awarded annually in spring following evaluation of student proposals by a faculty committee. In addition to opportunities to conduct research in close collaboration with an in-house faculty member, students frequently work with an off-campus researcher affiliated with a private company, a university, or a national laboratory. Many students apply for NSF-sponsored summer research programs off campus. We encourage STEM students to take advantage of these opportunities whenever possible. In addition, Bethel science faculty provide inquiry-oriented laboratory experiences, even in introductory courses, as has been advocated in a recent national conference on undergraduate biology education (Brewer and Smith, 2011). Because faculty enthusiasm for research is often "infectious," it is important to expose students to teaching faculty who are active in research and who integrate their research interests with their regular teaching. For instance, both of us have had research grants that include students as collaborative researchers.

In STEM programs, investigations and projects help students develop such 21st century proficiencies as adaptability, communication skills, social skills, non-routine problem solving, self-management, collaboration, and systems thinking (Bybee, 2010; NRC, 2010). The competencies that today's citizens need to understand and address include such critical global issues as energy efficiency, resource use, climate change, environmental quality, and hazard mitigation and are clearly related to STEM disciplines.

Group projects

STEM Learning Community provides a natural mechanism for introducing lower-level students to the research process and for mentoring by upper-class majors for freshman and sophomore students (i.e., vertically integrated research groups). A hallmark of SLC is the interdisciplinary group project that accompanies classroom content and presentations by speakers. These projects bring together students of different college classes and with different STEM interests in a common research effort. Each interdisciplinary group is composed of three to five students. Students meet together and with their faculty advisor throughout the fall and spring, conduct a literature search pertinent to their topic, collect and analyze data, and create a poster for the college's annual undergraduate research (Undergraduate Research, Internships and Creative Activity, URICA) symposium.

In the first two years, collaborative group projects were essentially designed by the faculty and presented to students as options. These first generation projects were organized principally around such interdisciplinary topics as climate change, carbon budgets, energy or materials conservation on campus, biodiversity, and public health issues related to climate change. In the latter years, and largely in response to students' requests for more latitude in choosing their topics, we expanded the range of research possibilities to include more topics in the biomedical and behavioral sciences. Groups conceive research plans, then submit proposals in fall, and post regular progress reports and data files using our Moodle course management software.

URICA symposium

A highlight for SLC students is their participation in the College's URICA Symposium which takes place in late April and thereby serves as a "capstone" event

for all undergraduate research on campus. The URICA Symposium begins Thursday evening and continues through Friday afternoon. On Friday, there are three concurrent sessions at 11:00 a.m. across campus featuring student research presentations that have been nominated by faculty. Presentations continue throughout the afternoon, with Friday afternoon classes cancelled so that all students can attend and participate. The Symposium provides opportunity for seniors and other undergraduate researchers to present their findings in a campus-wide public setting. Oral presentations, poster sessions, and internship panels are regular parts of the Symposium and generate considerable interest and discussion. Following the Symposium, the posters created by the SLC research groups are mounted on the walls of the various departments in Krehbiel Science Center for permanent public display.

Provide bridges to graduate programs and careers

The third component of the program provides career information and advising to students, especially by incorporating this effort into regular programming of the STEM Learning Community. We invite scientists, medical professionals, science teachers, and prospective employers to provide presentations about science-related opportunities. We have also developed a broad-based internship program (described below) that provides incentives for participation in the form of stipends. The intent is to provide first-hand exposure for our students to STEM-related career opportunities that will encourage them to complete a STEM four-year degree and to pursue science-related graduate or professional study afterward.

Career preparation: internships

A recent report of the Association of American Colleges and Universities identified internships (including undergraduate research) as a high-impact educational practice for achieving the goals of a liberal education (Kuh, 2008). Thus, internships have become signature programs for some colleges (Aldas et al., 2010; Gavigan, 2010; Pierson and Troppe, 2010). A factor important in preparing students for the science and technology workforce is the opportunity for substantive interaction with mentors from science and technology fields. Internships and mentorships often encourage student engagement in learning and intentional exploration of career alternatives, and enable faculty involvement in helping students develop and pursue career aspirations (O'Neill, 2010).

To provide additional components to the STEM Learning Community course and the attendant junior/senior seminar, we are pursuing ways to provide bridges to STEM careers and graduate programs. In summer 2013, we inaugurated a new program, entitled the RICHE (Research and Internships for Careers in Health and the Environment) Initiative, to fund science-related research and internship experiences on or off campus. We have compiled a list of individuals among our STEM alumni representing a wide range of academic, medical, chemical, engineering, and software industries and who could sponsor internships, provide tours of facilities, and promote career opportunities. The core of this alumni base is a 20-member STEM Advisory Council formed in 2006. Since 2013, a total of 16 students have received RICHE funding to support internships. Awardees are required to keep a journal (using Mahara e-portfolio software) in which they comment on their plans and preferences regarding a major and career and how the internship is benefiting them. At the conclusion, students report on their internships to the SLC class and serve on a career panel during the URICA Symposium.

Another aspect of our effort to bridge learning and the world of work is the annual STEM Symposium—a component since 2007 of the College's annual October alumni weekend event that brings thousands of visitors to campus, including many STEM alumni. The schedule includes research presentations on Friday followed by a panel on STEM career paths. Again, afternoon classes are cancelled to allow student attendance. A reception late Friday afternoon encourages and maximizes interaction between speakers, STEM alumni, and undergraduates. The event closes with a keynote address and STEM coffee on Saturday morning.

Finally, career preparation is thoroughly integrated into the content of the SLC course too. As a class assignment, students are directed to write on their career plans, create an ePortfolio using Mahara, pursue employment in STEM departments, seek research and internship experiences on or off campus, and attend career panels during the STEM and URICA Symposia. These efforts involve extensive collaboration with the College's Office of Experiential Learning and Career Services, class presentations and assignments, development of on-line resources available through the Moodle site for the course, and invited speakers and other communications with STEM alumni.

Evaluation topic	2009/10	2010/11	2011/12	2012/13
The scholarship had a large financial impact on my ability to pursue my program of study	4.9	4.9	4.9	4.5
I have improved my understanding of the research process	4.4	4.5	4.8	5.0
I feel that I have had adequate academic assistance for my program of study	4.5	4.4	4.7	4.7
I have gained confidence in myself as a successful learner	4.7	4.1	4.4	4.8
I am aware of opportunities to participate in research projects and other STEM-related activities outside the classroom	4.3	4.3	4.2	5.0
The STEM program has enhanced my academic skills	4.4	4.3	4.4	4.7
I feel that I have been or am being prepared well for a career in a STEM field	4.7	3.9	4.3	4.7
I have increased my awareness of the career options available to me as a STEM major	4.6	3.9	4.2	4.3
I feel that I have had adequate career counseling	4.5	3.9	4.3	4.0

TABLE 1. Results of summative program evaluations for STEM scholarship recipients from spring 2010 to spring 2013. Values are means of scaled responses where 1=disagree strongly and 5=agree strongly. Categories are ranked in order of descending mean four-year scores.

Course/program assessments

For interdisciplinary programs like ours, valid forms of assessing the instructional impact on learning should focus on such components as problem solving ability and communication skills as opposed to content knowledge. Thus, we designed a questionnaire specifically to survey students' perceptions of their academic skills, confidence, knowledge of the research process, research opportunities, career options, career preparation, access to academic assistance, and access to career counseling.

STEM student surveys

To evaluate the success of the program in meeting our objectives during the first four years, we administered end-of-year surveys to the scholarship recipients and to participating STEM faculty. The student survey aimed to assess the scholarship program in terms of its explicit goals (understanding the research process, preparation for a STEM career, etc.). The survey for STEM faculty was designed to gain important information to evaluate the success of the program mid-stream and to identify any areas that needed improvement. Here, we were particularly interested in evaluating and improving our means of promoting our STEM programs and recruiting historically underrepresented student groups.

In general, all the mean scores of student respondents were very strong (between 4.0 and 5.0 on a 1-5 scale),

with students citing especially the financial impact of the scholarship on their ability to attend college and pursue a STEM career, their understanding of the research process, and the level of academic support available to them (Table 1). Students highlighted in particular their strong relationships with STEM faculty, opportunities to learn about the research process, and excellent career preparation. Additional student comments mentioned the confidence and preparation they are gaining for a STEM profession, their increased awareness of career options, and, in particular, the great educational value they experienced in preparing for the URICA Symposium and the close working relationships they enjoyed with STEM faculty. The hands-on aspects of the research process enhanced their understanding of science, and exposure to senior thesis research helped "de-mystify" the process for beginning students.

In the addition to the questions shown in Table 1, in the fourth year we asked graduating scholarship recipients to reflect also on their several years' experience with the program, and to provide commentary on their studies, career preparation, and suggestions to improve the STEM scholarship program. Many students appreciated the emphasis placed on identifying and exploring their career interests, connecting with alumni working in their area of interest, learning how to formulate questions and develop a full research project, and the importance of integrating younger students into a senior research group.

In response to the relatively low mean scores in the second year reflecting a perceived need for more directed career counseling, we made several explicit changes to increase our efforts in this area. Notably, we began working more in tandem with our Office of Career Services and Experiential Learning (including class presentations to the SLC students by our Director of Career Counseling), and devoted more sessions to career information, including providing numerous links to web sites on the course Moodle site, writing assignments to identify career goals, and assignments on building a resume using Mahara e-portfolio software. Moreover, there were several opportunities for students to speak directly with STEM professionals who visited our campus or via Skype.

In the third year, several students and faculty recognized that juniors were lacking the research opportunities available to SLC students (who were involved in group projects in the first two years) and seniors (who were completing their research theses). In response, we explicitly integrated research groups vertically by incorporating lower-level students into senior research projects or by designing ad hoc research groups that involved freshmen through junior students. In this way, upper-level students began to serve in a mentoring role for beginning students.

Faculty surveys

Clearly, the points of greatest strength identified by STEM faculty were the student-centered areas of academic support, opportunities to conduct research, improved understanding of the research process, and enhancement of students' academic skills (Table 2). STEM faculty identified the scholarship interview as an important tool for recruiting prospective students into STEM programs. The interview represents the initial step in developing long-term relationships between students and their STEM advisors.

Faculty emphasized the value of the SLC course in bringing diverse groups of students together to work collaboratively to address common research topics, and commented that requiring students to participate in the URICA Symposium granted freshmen and sophomores a level of accountability that had not existed previously. The learning community enhances a variety of transferable skills: lab techniques, data analysis and interpretation, presentation of scientific results, and team work. Integrating research groups vertically among classes allows upper level students to assume mentoring roles for beginning students and potentially build upon research projects from one year to the next. There was concern expressed early about providing a seamless transition from freshman/sophomore group projects to senior-level thesis research, which was addressed in the way we re-formulated collaborative research groups.

Reflecting on the degree to which the project is increasing overall enrollments in science and mathematics, several faculty members commented that the scholarships, integrated with SLC and career advising, has revitalized our entire science program. Students are considerably more involved in their STEM majors now, and appear much more capable of conceiving and putting together research projects, than they were a few years ago. Faculty members also appreciate the opportunity to mentor students earlier in their educational training to encourage an interest in science and to discuss career opportunities. There is increased awareness among students of the need to be systematic in preparing for a STEM career.

In the inaugural year, faculty identified some difficulties in moving beyond traditional approaches in recruiting students; need for more outreach, especially to minority students; still insufficient institutional support for recruitment; and ineffective advertisement and promotion of the scholarship program. We succeeded in overcoming many of these barriers through a generally cooperative frame of mind among STEM departments and better communication among faculty, Admissions, the Financial Aid Office, and students. In the opinion of the authors, however, recruitment of minority students into STEM disciplines continues to lag behind expectations. Thus, we continue to seek more minority and female students in the sciences, and are exploring new ways of marketing to them. For example, six years ago we began a partnership with the Upward Bound Science and Math program at nearby Wichita State University to identify and sponsor in particular minority and first-generation college students for our annual Summer Science Institute.

STEM Learning Community student evaluations

Evaluation for the SLC class was a part of the College's regular program of course evaluations to assess instructors' effectiveness in delivering course content. The format of the evaluation changed from the 2010/2011 to

Evaluative statement	2009/10	2010/11	2011/12
Meaningful opportunities to conduct research were provided	4.6	5.0	4.5
Students were given both academic and personal support	4.7	4.8	4.2
Students are improving their understanding of the research process	4.5	4.8	4.2
Students are enhancing their academic skills	4.5	4.8	4.0
Students are moving toward the planned goals of the project	4.4	4.2	4.1
The appropriate students were selected to receive a STEM scholarship	4.3	4.2	4.0
The number of students entering a STEM program is increasing	4.0	4.0	4.3
The number of prospective STEM students reached is increasing	4.0	4.2	3.7
Students are being retained in STEM programs at an increasing rate	3.8	4.0	3.3
I encountered barriers to implementing this program	3.0	1.5	3.0
A solid management plan was developed and followed	4.6	4.2	--
The recruitment strategies were successful	3.8	4.0	--
Appropriate recruitment strategies were employed	3.8	3.7	--

TABLE 2. Results of mid-program evaluations administered to participating STEM faculty in 2010, 2011, and 2012. Values are means of scaled responses where 1=disagree strongly and 5=agree strongly. Responses are ranked by decreasing overall three-year score.

Evaluation topic	2009/2010	2010/2011
Instructors facilitated student involvement in this class	2.6	2.5
Instructors were available for individual help when needed	2.6	2.3
Readings enhanced my learning in this course	2.6	2.2
Instructors' presentations were well organized	2.2	2.3
Syllabus clearly stated the learning objectives, schedule, and grading system of the course	2.2	2.3
Evaluation tools used in this course were consistent with the course objectives	2.3	2.2
Assignments enhanced my learning in this course	2.2	2.2
Teaching strategies of the instructors enhanced my understanding of the material	2.2	2.1

TABLE 3a. Results of student evaluations of the STEM Learning Community course in spring 2010 and 2011. Values are means of scaled responses where 1=disagree, 2=agree, and 3=agree strongly. Topics are ranked by overall decreasing two-year score. The questions were from the standard course evaluations used for all Bethel College courses.

Evaluation topic	2011/2012	2012/2013
Instructors were available for individual help when needed	100	100
Instructors' presentations were well organized	100	100
Evaluation tools used in this course were consistent with the course objectives	100	100
Syllabus clearly stated the learning objectives, schedule, and grading system of the course	100	100
Instructors facilitated student involvement in this class	89	100
Readings enhanced my learning in this course	94	94
Teaching strategies of the instructors enhanced my understanding of the material	100	80
Assignments enhanced my learning in this course	89	82

TABLE 3b. Results of student evaluations of the course of the STEM Learning Community course in spring 2012 and 2013. Students responded along a four-category scale from 'strongly disagree' to 'strongly agree.' Values are combined percentages of students who responded either 'Agree' or 'Agree strongly,' ranked by overall decreasing two-year score. The questions were from the standard course evaluations used for all Bethel College courses, whose format changed from 2011 to 2012.

the 2011/2012 academic years, thus the results are not directly comparable across the four years.

Responses to the surveys administered to the SLC students in the first two years showed that, in general, students responded well to this interdisciplinary course (Table 3a). Students mentioned that they appreciated the opportunity to hear progress reports from juniors and seniors working on their thesis research, group discussions on ethics in science, history of science, collaborative hands-on study of a common topic, presentations by guest speakers, and participation in the URICA Symposium. Students commented further on the value of the research experience in preparing for graduate school, how exposure to senior thesis presentations helped beginning students generate project ideas of their own, the importance of career sessions, and the educational experience gained through reading and critiquing scientific papers.

When asked about ways to improve the teaching or content of the course, a few students cited the large time commitment involved in completing group projects, questioned whether there could be more latitude in choices of topics for group projects, and recommended greater integration among beginning and more experienced students.

Responses to the survey administered to the SLC students in the third and fourth years showed that, in general, students were continuing to respond favorably to this interdisciplinary course, with nearly all scores falling within the 'agree' and 'agree strongly' categories (Table 3b). When asked to identify which aspects of the teaching or content of the course students found especially helpful most students mentioned the group projects, the hands-on nature of the course, and the instructor's expertise, availability, and willingness to assist. Several students appreciated in particular the skills they developed in conducting research and completing a scientific poster, and that they enjoyed collaborating with juniors and seniors.

STEM faculty benefit from the SLC experience, too. The program provides faculty with various opportunities to work with a diverse group of students, both in terms of students' backgrounds and in disciplinary interests. Faculty members gain experience in finding engaging readings for this diverse group, and working together across departments to provide common content. Instructors have also gained expertise in finding integrative themes for research that span multiple disciplines and guiding first-year students in developing researchable questions.

A main objective of our scholarship program was to attract more students, especially women, minorities, and first-generation college students, into STEM majors (Objective I). Three metrics are useful to examine progress toward meeting this objective: (1) enrollment in and demography of STEM Learning Community as an indicator of freshman/sophomore interest in STEM majors, (2) enrollment and demography of STEM students involved in junior/senior seminar courses, (3) number of graduates with STEM majors for the previous five years.

Enrollment in STEM Learning Community

One indicator of the progress made toward meeting Objective I is the number and makeup of students enrolled in the freshman/sophomore interdisciplinary course, STEM Learning Community. This enrollment provides a gauge of both early interest in STEM and potential number of majors and graduates a few years hence.

Involvement in SLC ranged from 19 to 32 students annually during this period (Table 4). Averaged across years, the course membership was predominantly female (64.5%) and had a minority student constituency of 9.7%. Six years is insufficient time to identify strong trends, but the numbers in the last four years certainly represent higher proportions of women and minority students than in the first two years. Of course, not every student who enrolls in SLC in their first two early years ultimately majors in STEM. These figures, however, are strongly indicative of eventual formal STEM involvement.

Academic Year	Enrollment	Total (%) female	Minority female	Total male	Minority male
2009-2010	19	11 (57.9)	1	8	0
2010-2011	26	11 (42.3)	1	15	0
2011-2012	30	19 (63.3)	3	11	2
2012-2013	25	21 (84.0)	1	4	1
2013-2014	23	17 (73.9)	2	6	2
2014-2015	32	21 (65.6)	2	11	0

TABLE 4. Enrollment in the STEM Learning Community course during its first six years.

Academic year	Combined enrollment	% women	% minority
2008-2009	34	41.2	5.9
2009-2010	43	39.5	9.3
2010-2011	49	65.3	10.2
2011-2012	53	52.8	5.7
2012-2013	50	46.0	16.0
2013-2014	52	48.1	21.2
2014-2015	44	61.4	9.1

TABLE 5. Enrollments in STEM (biology, chemistry, computer science, mathematics, physics, and psychology) junior/senior seminars 2008 through 2015.

Major	2008	2009	2010	2011	2012	2013	2014
Biology	5	9	3	5	7	7	9
Chemistry	5	1	2	1	5	4	5
Mathematics/Computer Sci.	3	5	4	7	5	3	5
Natural Sciences	2	0	1	1	4	6	2
Physics	1	1	3	1	0	1	0
Psychology	6	5	4	5	6	6	6
Total	22	21	17	20	27	27	27
Percentage of all graduates	17.1	17.6	19.1	21.7	26.7	25.5	25.5

TABLE 6. Number of majors in STEM fields among Bethel College graduates 2008 to 2014. Majors for the years immediately prior to the STEM Learning Community course (2007/2008, 2008/2009) are shown for comparison.

Enrollments in junior/senior seminars

A second indicator whether the number of STEM students increased is the change in annual enrollments in our various upper-level seminar courses, which are graduation requirements for all STEM majors. The organizing principle is that SLC serves to "feed" students into upper level departmental seminars, and that increasing numbers of women and minorities in SLC will be manifested in STEM majors one or two years later. These seven years' data show generally higher overall enrollments in the latter years of the evaluation period, as well as generally higher proportional representations by both women and minority students (Table 5).

Number of STEM majors among graduates

A third indicator of our progress toward meeting Objective I of the program is the number of students persisting to graduate with a STEM major. Again, trends are hard to discern over a brief period, but overall numbers of majors were clearly higher in the latter three years of the program than in the earlier years (Table 6), a 26% mean increase from 2008-2009 to 2012-2014. It is noteworthy that the first cohort of sophomore SLC students graduated in 2012, the year in which the bump in numbers of graduates first appeared.

Conclusions

In terms of meeting the goals of increasing the numbers of STEM students, especially among women, minorities, and students with large financial need, the program is clearly making progress. The enrollment and demographic indicators all changed positively, although additional years are required to determine whether these trends hold for the long term. Beyond providing essential financial support for students in STEM, the scholarship and academic support program has led to significant institutional change, notably in the creation of the course STEM Learning Community, which has now become a permanent part of the Bethel College curriculum. The SLC class, perhaps the most visible success of the program, has, with some minor adjustment, achieved all the objectives we set out to accomplish. This class provides beginning college students exposure to STEM disciplines in a way that never existed previously on our campus.

Additional effective components of this program are the integration of beginning students with more advanced students in group projects, increasing involvement by women and minority students in SLC and various STEM seminars, the URICA Symposium, and the increased programming on career preparation. There is an increasing emphasis on experiential learning on our campus of which STEM research and internships are central components.

An advantage of the SLC model is that all aspects are replicable and transportable elsewhere. Versions of the SLC course will work on any campus where faculty can work collaboratively across departments to provide common course content and to oversee group projects. Our criteria for identifying and selecting scholarship awardees could be employed anywhere STEM faculty are willing to participate actively in the recruitment process, including devoting 30 minutes to interview scholarship candidates and meeting as a group to deliberate on awardees.

Of course, the ultimate assessment would measure the extent to which these programs increase the numbers of graduates who successfully enter STEM professions. Such an assessment, although outside the scope of this project, is ongoing and involves collaboration with the College's Office of Alumni Relations. Final conclusions regarding the success of our STEM recruitment program await the completion of this assessment.

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