D. Project Description

1. Introduction

The STEM departments of Bridgewater State College (BSC) request funding to implement a coherent set of interventions designed to increase STEM graduation rates. This is accomplished by interventions implemented primarily in the first two years that aim to improve the quality of student learning in STEM classes and to infuse preparatory groundwork for junior and senior level undergraduate research and internships into classes and mentoring experiences. As an institutional effort, **ST**udent **R**etention **E**nhancement **A**cross **M**athematics and **S**ciences (**STREAMS**) will introduce a common approach to teaching introductory STEM courses in the departments of biology, chemistry, earth sciences, physics, and mathematics and computer science that relies on inquiry-based learning with attached structured learning assistance provided by advanced undergraduate students. Beginning STEM majors will develop better connections to their senior peers and their departments through the creation of a residential learning community and a mentoring program that specifically aims to prepare students for advanced lab or field experiences later in their careers. A target group of traditionally underserved students (low income, students of color, and first generation students) with weaker mathematics skills will benefit from a residential summer bridge program. The needs of transfer students will be addressed systematically and ties to local community colleges will be strengthened.

Students who are first generation, low income, or of diverse racial backgrounds make up 42% of the incoming BSC first-time freshmen. The STREAMS interventions are rooted in the intersection of the literature for increasing graduation rates for these traditionally underserved students and STEM students. A 2007 Hannover Research Council report on underserved population finds that academic retention is strongly correlated with good advising, the development of academic goals through mentoring, and improvements in academics skills, and Kuh (2008) finds that common intellectual experiences, learning communities, collaborative assignments and projects and undergraduate research are high impact educational practices that enable strong retention within underserved groups. Similar results are found in the NSF contracted report by Sharp et al. where it was found that bridge programs that increase preparation levels, effective mentoring and alliance structures, and undergraduate research are keys to success for minority students in STEM. STREAMS will substantially increase student engagement by implementing a common approach to teaching in all introductory courses using inquiry-based learning (Farrell et al., 1999; Hanson and Wolfskill, 2000; Hinde and Kovac, 2001; Lewis and Lewis, 2005; Ebert-May and Brewer 1997), group assignments (Student Engagement and Effect on Retention, 2007; NSSE 2000; Guskin 1997; Amelink 2005), and structured learning assistance (Hensen, K. & Shelley, M. 2003) which have been shown to be successful in promoting student success in both STEM and underserved populations.

The STREAMS proposal is based on strong, existing assessment data drawn from extensive surveys of BSC students, faculty focus groups, and institutional research of BSC students in STEM, with a particular interest given to traditionally underserved populations and women. Existing assessment programs put BSC in a strong position to carry out further assessment for this grant and allow for clearly defined goals for retention and graduation rates.

Further, institutional commitments and support in writing the STREAMS proposal from all BSC STEM departments, leading academic officers, and the directors of the Offices of Institutional Research and Assessment, Institutional Diversity, Teaching and Learning, and Undergraduate Research provide a solid foundation for successful implementation. STREAMS is a natural outgrowth of successes on campus and will enable a significant step in the development of student success.

2. BSC Mission and Region

Bridgewater State College, the largest of the Massachusetts state colleges and the fourth largest of the 29 public colleges or universities in the Commonwealth (including the University of Massachusetts and the community colleges), has an institutional commitment to quality, affordable undergraduate education. BSC serves 10,269 students or 8,120 FTE (Fall 2008) with an average of 122 degrees granted annually between 2003 and 2007 in biology, chemistry, computer science, earth science, mathematics and physics. The mission of BSC, revised and adopted in 1999, is "to educate the residents of southeastern Massachusetts and the Commonwealth, and to use the college's intellectual, scientific, and technological resources to support and advance the economic and cultural life of the region and the state."

Situated in the center of Southeastern Massachusetts just thirty miles south of Boston, BSC provides access to affordable public higher education for 1.5 million residents in the fastest growing region in the Commonwealth; the Census Bureau predicts the population in the region to grow by 8.8% between 2000 and 2020. As a result of population growth and a lack of affordable higher education in the region, BSC undergraduate enrollment has increased each of the past six years, with a total increase in undergraduate FTE of 8% since 2003. Enrollments by students of color have also steadily increased to 9.8% of the student population in fall 2007.

BSC STEM graduates are employed in the region's high-technology firms, continue their education at the graduate level and pursue careers as teachers in primary and secondary education in roughly equal numbers. In recent years, institutionally supported initiatives at BSC have bolstered our graduates' success in these areas. Undergraduate research at BSC is already strongly supported by college initiatives and has led to significant numbers of BSC students successfully pursuing graduate studies. BSC's School of Education is one of the largest in the state, and BSC STEM graduates are the primary source for secondary education teachers in the region, helping to fill a well-known gap in the country's STEM infrastructure outlined in the October 2007 National Science Board National Action Plan for STEM education.

3. BSC Institutional Readiness for STREAMS

BSC is institutionally ready to implement the STREAMS program. At the institutional level, the Office of Institutional Diversity has raised the awareness of different learning styles and inclusive pedagogies through a host of faculty development programs. BSC STEM faculty feel a new synergy from the proposed creation of a new School of Science and Mathematics (planned for fall 2010). This synergy is augmented by the development of new capacity with the fall 2009 groundbreaking of a LEED-certified science complex.

BSC is a recipient of a Nellie Mae Foundation Project Compass Grant, awarded in 2007 through 2012, that supports institutional programs and strategies that strive to eliminate achievement gaps and significantly increase academic success, retention, and graduation rates for minority and low-income undergraduate students. Project Compass is administered by the Director of the Office of Institutional Diversity, who works with faculty to increase the use of inclusive pedagogies that have been shown to support all student learners. Over the past two years, the Project Compass Community of Practice and the Director of Teaching and Learning (DTL) have led discussions of the effectiveness of inclusive pedagogies on campus, from which the ideas and faculty support for STREAMS directly grew.

With the fall 2009 groundbreaking of a LEED-certified science complex that will house all STEM departments for the first time, BSC has the capacity to increase its STEM graduates. The $98.7 million facility will nearly double the current undergraduate teaching lab space and provide dedicated research lab space for the first time. The new building has also given renewed strength and intentionality to collaborations between the STEM departments, and this

grant proposal will both strengthen and operationalize those collaborations. The new building will house a Dean's office of the planned School of Science and Mathematics.

4. BSC STEM population

From 2003 to 2007, BSC has averaged a nearly constant 701 STEM majors in biology, chemistry, computer science, earth sciences, mathematics, and physics and granted an average of 122 STEM degrees each year. For 2007, 57% of the STEM majors and 55% of STEM degree recipients were female, tracking BSC's overall gender disparity of 59% female. Students of color represented 9.3% of STEM majors in 2007, close to the BSC average (9.8%).

Through data gathered by Project Compass, BSC has studied a group of traditionally underserved students that accounts for 42% of BSC first time freshmen in fall 2008: students of color (12%), low income students (14.6%), and first generation students (30%). First-time, full-time (FTFT) first year women, students of color (SOC) and low-income students (L) are retained in STEM at comparable rates to the overall STEM population. In the table below, Year 1-2 and 2-3 retention is defined as the percentage of students officially enrolled in a STEM discipline in their 1st (or 2nd) year who continued in a STEM discipline in the 2nd (or 3rd) year.

Cohort Year	STEM cohort FTFT	STEM Year 1-2	STEM Year 2-3	Female cohort FTFT	Female Year 1-2	Female Year 2-3	L/SOC cohort FTFT	L/SOC Year 1-2	L/SOC Year 2-3
2005	121	54.5 %	69.7 %	56	51.8 %	62.1 %	36	58.3 %	66.7%
2006	126	60.3 %	73.7 %	55	70.9 %	66.7%	29	55.2 %	56.2 %

The table below shows the overall number of declared STEM majors and retention data (regardless of first-time or full-time status) who were freshman (less than 30 credits) in the fall of 2005, sophomores (30 to 60 credits) in the fall of 2006, and juniors (60 to 90 credits) in the fall of 2007. We see that in both the freshmen and sophomore years, a large number of students change to a non-STEM major or separate from the college. We also see that a large number of students are *added* to the STEM population each year. While only 82 of 155 fall 2005 freshmen were retained to the sophomore year, the number of sophomores in the fall 2006 is 175. This increase is mostly due to undeclared BSC freshman taking an introductory course and changing to a STEM major. The significant sophomore to junior increase (from 109 to 161) is due largely to transfer students. By the junior year, about 80% of all STEM majors graduate within STEM.

OVERALL STEM	Initial Cohort	Still Enrolled or Graduated (the succeeding Fall)								Not Enrolled	
		Same Major		Diff Major STEM		Diff Major Not STEM		Total			
Fresh. (Fall 05)	155	81	52%	1	1%	29	19%	111	72%	44	28%
Soph. (Fall 06)	175	100	57%	9	5%	31	18%	140	80%	35	20%
Juniors (Fall 07)	161	127	79%	3	2%	17	11%	147	91%	14	9%

There is little variation between departments or in initial cohort year sizes in this pattern. Computer science shows a lower first year retention (only 35% for fall 2005 freshman), but normal second year retention (60% for fall 2006 sophomores). All departments show at least a 70% retention rate for juniors each year from 2005 to 2007. Surprisingly, there are no significant differences in rates between the overall STEM population, women, and students of color. The annual additions from retained freshmen to sophomores and from sophomores to juniors also remained relatively stable across years from 2005 to 2007.

Transfer students are an important potential source of STEM graduates at BSC because of its affordability and connections as a state college to the community colleges. However, transfer student retention in STEM is poor. In fall 2005, 42 students transferred to BSC as a STEM major. For these 42 students, the one year persistence rate within STEM was 54.8%. Only 38.1% of this cohort was retained in STEM after two years, and ultimately, only 10 of the 42 fall 2005 STEM transfer students graduated within 3 years (23.8%).

5. Identified STEM Barriers

Studies of course statistics, student surveys, and faculty focus groups indicate specific BSC barriers to STEM persistence and graduation. STREAMS is designed to address the top barriers: structural elements in the delivery of course content, student preparation, student academic confidence, and a lack of awareness of how to navigate college.

Self-assessment of BSC first-time freshman through the Cooperative Institutional Research Program, or CIRP (Higher Education Research Institute), survey indicates a substantial lack of academic confidence skills and a greater concern surrounding cost compared to the national average. BSC freshman rate themselves at significantly lower rates compared to their national peers in the areas of academic ability (47.4% BSC to 57.1% nationally), drive to achieve (59.9% to 68.3%), and intellectual (40.7% to 53.0%) and social self-confidence (39.9% to 50.4%). In addition, cost of attendance emerges as a highly significant factor (63.6% BSC to 46.8% nationally), and BSC students are far more likely than their national peers to work for pay more than 11 hours per week (65.9% to 53.5%).

STEM faculty focus groups indicate that general college and mathematical preparation is a significant barrier in introductory STEM courses, compounded by transition difficulties and a lack of STEM understanding. BSC faculty report that students have difficulty adjusting to the expected level and kinds of work required for success. They also believe that students have romanticized notion of the practice of science and math that interferes with success. BSC STEM faculty agree that stronger mentoring, learning communities, improved pedagogy and additional student learning assistance will help to alleviate these difficulties.

Project Compass research has identified six gateway courses with high occurrence of grades of D, F, or withdrawal: Computer Science 101, Chemistry 141, Math 151 (Calculus for math and physics majors), Physics 243 (calculus-based physics), Math 141 (calculus for biology and some chemistry majors), and Biology 121. In each class, at least 33.3%, and as many as 46.7%, of students taking the class received a grade worse than C. In a survey of 114 students who completed a gateway course in 2008-2009, 65% of students who discontinued their STEM major stated that their class performance was a significant factor, and 42% stated that lack of effective mentoring was a significant factor. Overall, 29% of students considered their total course load to be a moderate to significant negative factor in their class success, and 15% and 14% of students indicated that course instruction and the extent to which the instructor was perceived as caring were significant factors, respectively. (Although we note that 30% and 38% of respondents indicated that these two factors significantly helped their class performance.)

6. Current Efforts

Introductory STEM courses enroll fewer than 36 students in science and 25 students in mathematics and are taught by faculty who view teaching as their primary mission. The effect of small class size is supported by institutional strengths that will be built upon by STREAMS.

1) Course pedagogical improvements are supported by Presidential Development Grants of $3500. In STEM, these grants have encouraged the inclusion of undergraduate research in upper level computer science courses, the development of a pervasive green chemistry curriculum, and new approaches in biology labs and aviation physics.

2) In 2002, the Academic Achievement Center implemented a comprehensive First Year Advising Program, which increased retention rates among students overall and, specifically, students of color (SOC). The average rates in the five year period before the program were 72.3% (61.3% soc) for first to second year and 83.9% (80.0% soc) for second to third year retention. Between 2002 and 2006, the first to second year college-wide retention rate was 76% (70.8% soc), and the second to third year retention rate was 86.9% (84.6% soc).

3) Targeted learning assistance is provided for students whose declared major requires calculus but who place into precalculus (Math 100). In fall 2008, at risk students in assisted Math 100 had DFW rates lower than students in regular Math 100 (18% to 31%). Dr. Matthew Salomone, (Director of Mathematical Services and co-I), oversees this initiative.

4) The Office of Undergraduate Research and the Adrian Tinsley Program for Undergraduate Research fund undergraduate student research with a 2009-2010 academic year budget of $392,000. Included are a summer undergraduate research program with over 25 projects each year (an average of 10 per year in STEM) and smaller semester grants for research conducted through independent studies or classes. Beginning in the fall 2008 semester, over 25 semester research awards were received by STEM majors each semester. In 2008-2009, 10 STEM students received travel grants to present at professional meetings and 6 additional STEM students presented their work at the National Conference for Undergraduate Research. *The Undergraduate Review*, an annual publication of top BSC undergraduate research and writing, includes an average of 6 STEM projects each year.

5) All first and second year students are supported by new core curriculum implemented in 2006 that focuses on critical thinking, writing, and quantitative reasoning skills. Students take content-based first and second year seminars that require students to write or speak within disciplines at an early stage in their academic career.

6) Structured Learning Assistance is provided to all students with low writing placement scores in targeted English 101 (TEng 101) sections where they receive structured additional writing and reading support. Students TEng 101 show lower DFW rates in First Year Seminar than students in regular English 101 sections.

7) BSC has a strong Office of Institutional Research and Assessment (OIRA) that works with faculty to conduct program and departmental reviews. Through the Project Compass grant, OIRA is already collecting most of the data that the STREAMS assessment requires.

7. Program Objectives and Benchmarks

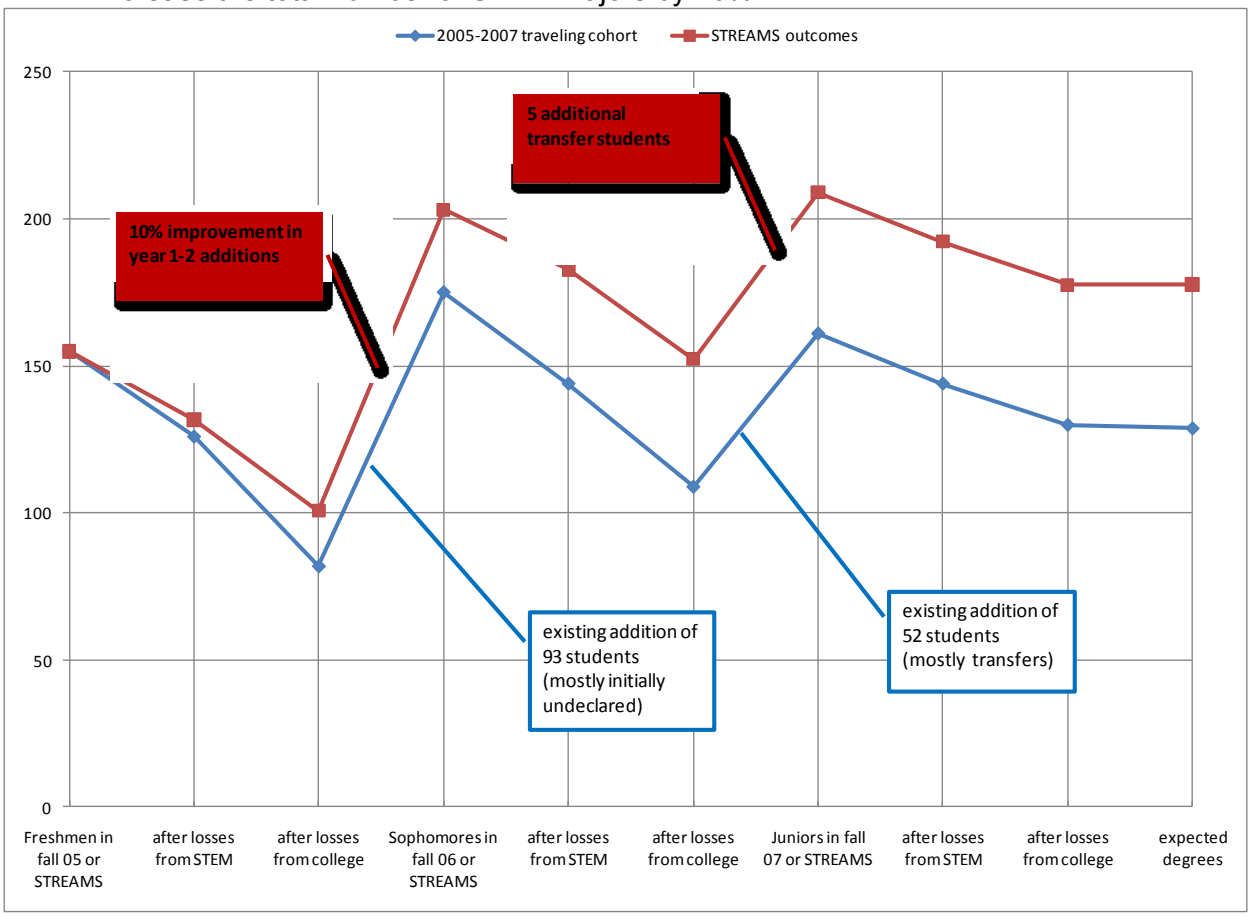
STREAMS at BSC will increase its total number of STEM graduates overall by 40 students per year or more from an average of just over 120 to about 160 per year. The graph below shows the progress of the 2005-2007 cohort from the table in section 4 overlaid with projected improvements from STREAMS assuming that the initial cohort size is the same.

Modest changes in the number of students lost to other majors and from the college can result in nearly 50 additional STEM graduates. For freshmen, 15% will change to a non-STEM major (down from 19%) and 20% will separate from the college (down from 28%). For sophomores, 10% will change to a non-STEM major (down from 18%) and 15% will separate (down from 20%). The larger change in sophomore rates reflects better mentoring and course preparation through the first two years. The Year 1 to 2 addition of students is 10% more than the current level – based on the assumption that better teaching will maintain more students who were initially undeclared freshmen. The Year 2 to 3 addition is based on increasing by 5 the number of students transferring to BSC in STEM.

The interventions of STREAMS will improve first to second year persistence in STEM majors from 53% to 65% and second to third year STEM persistence from 62% to 75% through curricular redesign, student support, and mentoring. By developing better transfer student

advising and coordination, more transfer students will succeed in graduating with STEM degrees. Additional STREAMS benchmarks beginning in year 3 of the grant include

1. decrease the DFW rates in key gateway courses to under 20%
2. increase the one year persistence rates of transfer students from 54% to 65%
3. increase the number of STEM transfer students by 5 per year
4. increase the total number of STEM majors by 10%.



8. Program Components

The STREAMS interventions respond to locally identified barriers including academic self-confidence, the need for strong mentoring, and student preparation levels while increasing the quality of instruction. All interventions are open to all BSC STEM students, with the exception of the Summer Bridge Program, which is designed to jumpstart women and traditionally underserved population students: students of color, first generation college students, and low income students.

8.1: Common Inquiry-Based Learning Approach

Student surveys and faculty focus groups identified the delivery of course content and a lack of alignment between the learning process and the true activities of scientists and mathematicians as key barriers to student success in introductory STEM courses. In response, STREAMS will strengthen the use of inquiry-based learning and group assignments in introductory STEM courses. In a meeting arranged by the Dean of the School of Arts and Sciences, the department chairs of biology, chemistry, earth science, mathematics and

computer science, and physics have agreed to implement a common approach to inquiry-based learning across all STEM introductory courses.

Inquiry-based learning is an outgrowth of constructivist theory which assumes that knowledge is created in the mind of the learner. Enhanced student engagement, improved grade performance, and greater retention in STEM majors have all been cited in the STEM literature as positive outcomes of using inquiry based models (Schroeder and Greenbowe 2008, Gosser 2009).

In year 1, six department-level subcommittees (biology, chemistry, computer science, earth science, mathematics, and physics) will receive mini-grants to redesign curricula in introductory courses. The mini-grants will be modeled on the existing and successful BSC Presidential Course Development Grants. The department subcommittees will be assisted by the STREAMS Curriculum Team, consisting of the PI, the BSC Director of Teaching and Learning (DTL), and the BSC Director of Mathematics Services, to implement changes and encourage ongoing involvement in the STREAMS program. The department-level subcommittees will also clarify course objectives and develop metrics for those objectives. In year 2, the new curricula will be introduced in all STEM introductory courses. In year 3, the six department-level subcommittees will receive a second round of mini-grants to extend inquiry-based learning to intermediate-level courses, and those changes will be implemented in year 4. Year 4 will see a review of the departmental objectives with broad discussions across each department regarding successes and failures, with modifications to be implemented in year 5. In this way, STREAMS will institutionalize the introduction of a proven inquiry-based pedagogy at BSC by the completion of the grant.

As a result of these efforts, STREAMS will help departments redesign curricula that contain measureable learning objectives and assessment tools that share commonalities with other departments. These learning objectives and assessment tools will be used in program assessment to insure that increases in grades correspond to increases in understanding. All departments will implement a common approach to inquiry-based pedagogies by year 2 of the grant for introductory classes and year 4 for intermediate courses. STREAMS will develop formal relationships between departments to share objectives, assessments, and assessment results. In addition, inquiry-based learning projects will be presented in groups at the Midyear Symposium for First and Second Year Work, providing students in introductory courses with an opportunity to get an early start at the scholarly discourse.

8.2: Structured Learning Assistance

The STREAMS grant will attach student-led structured learning assistance (SLA) to initial gateway classes in STEM with high DFW rates. SLA will help students with poor preparation from high school and bolster academic confidence. Students in classes with Structured Learning Assistance will benefit from added instructional support in a low-risk environment that promotes inquiry and team solutions to problems. Combining inquiry-based learning, group assignments, and structured learning assistance has been shown to be successful in promoting student success in both STEM and underserved populations (Farrell et. al. 1999, Eberlein et.al. 2008).

Group assignments associated with structured learning assistance (SLA) have been shown to be successful in promoting student success in both STEM and underserved populations in general. Our proposed SLA model will involve peer-led team learning (PLTL) to promote conceptual understanding and reasoning (Cracolice and Deming 2005). Use of this approach has significantly improved retention in a wide range of STEM disciplines nationally and has been widely discussed by the STEM community. We will utilize undergraduate students that have completed the course to serve as peer leaders and facilitate discussions with a group of 6 to 8 students from the associated introductory STEM course. The structure and

content of these sessions will be designed by each respective STEM department through the mini-grants in 8.1. Our intent for the students in SLA is to collaboratively build conceptual understanding, become more knowledgeable of the course material, and develop improved reasoning skills. STEM community research over the last 20 years in a range of STEM disciplines indicates that use of PLTL increases the grade performance of students and thereby decreases the percentage of students that fail, withdraw, or drop relative to traditional, non-PLTL courses (Arendale 2004, Quitadamo et al 2009).

SLA will be piloted in selected chemistry and calculus sections with nine student leaders in year 1. Starting in year 2, 42 student leaders will lead SLA sections attached to courses with known high DFW rates. The table below indicates the introductory STEM courses that will receive SLA along with the number of SLA to be assigned and the approximate group size. SLA will be embedded in day, non-honors sections and all students in those sections will participate. The courses with SLA are introductory STEM major courses, cognates or mathematics gateways.

Course	Number of day sections	2008-2009 DFW rate	Number of SLA leaders	Approximate group size
Comp. Sci. 101	9	46.7 %	9	6
Chemistry 141	4	46.6 %	7	6
Math 151	9	46.5 %	9	8
Physics 243	2	38.1 %	4	6
Math 141	7	36.9 %	7	8
Biology 121	3	33.3 %	6	5

At BSC, SLA will be coordinated by the Curriculum Team and the Academic Achievement Center with specialized instruction and oversight given to student workers by departmental course instructors. Advanced undergraduate students will be employed for 10 hours per week to attend class and run three, two-hour long SLA small group sessions. Students in the gateway courses will be assigned to a SLA group and attendance will factor into course grades at the 5-10% level.

Assessment Benchmarks for Interventions 1 & 2: As a result of introducing inquiry-based curricula throughout the STEM majors and the attachment of SLA to high DFW rate gateway courses in years 2-5,

1. students will perform as well or better on assessment measures connected to course learning outcomes in years 2-5 compared with year 1
2. DFW rates in introductory STEM courses will be reduced to below 20%
3. students will report through surveys improved academic self-confidence.

8.3: Portfolios of Excellence & Undergraduate Research

STREAMS will implement a mentoring program that will assist students in navigating college's expectations and possibilities by creating STEM-specific Portfolio of Excellence (STEM-POE) cohorts. Mentoring is known to be an important component in enhancing the success of both underserved and STEM populations (Hannover RC, Sharp et al.). The STREAMS mentoring program is unique in that it simultaneously introduces academic and co-curricular experiences designed to set students on a path of academic responsibility and success, while preparing them for high-end undergraduate research or field experiences in their junior and senior years.

STEM-POE is an expansion of an existing BSC mentoring program (POE) designed to assist the Project Compass target group: students of color, low-income students, and first generation college goers. POE places students in cohorts with similar majors and interests.

Cohorts work with a faculty mentor and a peer mentor to make thoughtful choices about the curricular and co-curricular opportunities available to them during a first year of college. Students work with departmentally developed lists of appropriate activities and goals in a particular major and develop an action plan for each semester that identifies what opportunities they want to engage in. They reflect on the success or difficulty of their plan periodically during the semester and house their plans and reflections in an online portfolio.

STEM-POE would introduce students to the undergraduate research experience from their first year on and would ready them for intensive and extended research experience in the latter half of their college career. STEM-POE would have students participate in all of the above-identified POE experiences. Unique to STEM-POE students, however, portfolio documentation and mentoring would culminate in the creation of an (Adrian Tinsley Program) ATP Summer Research Grant application for the summer between their sophomore and junior year of college. As such, STEM-POE students would participate in the program for two years (and not the one that standard POE students participate in).

The STEM-POE program would be coordinated by Dr. Lee Torda, Director of Undergraduate Research and co-director of the current POE program. In year 1, 40 first-year students would participate, and the program would grow to support approximately 80 first and second year STEM majors.

ATP Course-Embedded Research Grants: In order to insure that STEM-POE students experience a rich and rigorous training for more advanced undergraduate research, faculty teaching introductory STEM-major courses would be encouraged to apply for ATP Course-Embedded Research Grants. These grants provide funds to faculty to embed modest, research experiences within their classrooms, particularly in first and second year classes. Participation in this grant program requires faculty to have students present or publish some product from the experience in one of the many on-campus venues for both that the office hosts, further augmenting STEM-POE students portfolio of experiences. Faculty development around the appropriate use of the Course-Embedded Research Grants will be run by the STEM-POE program coordinator as well as STEM faculty with successful UR agendas up and running.

8.4: STEM Residential Learning Community

BSC will create a STEM residential learning community (RLC) consisting of approximately 50 students based on the Virginia Tech Biological and Life Sciences Learning Community. The residential learning community will support student success in introductory courses by providing evening tutoring and will work to increase the understanding of STEM practice with programming in the community. Studies of RLC in underserved populations (Engstrom and Tinto, 2008) indicate that students in the learning communities are more highly engaged in their coursework and persist at better rates than their peers. At Virginia Tech, students living in the learning community had higher GPAs (significant at the $p=0.05$ level) than a control group taking the same classes but not living in the community (Turrentine, 2001).

Embedded in the RLC will be paid two Residential Mentors (RM) who are advanced STEM students. The RM will provide a total of 6 hours of supported study sessions per week open to any student, but students living in RLC will be required to attend at least three hours per week. At the supported study sessions, the RM will organize tutoring and group study. Together with a STEM major residential life assistant, the RM will develop programming that will include advanced students and STEM faculty discussing study strategies, what excites them about their advanced course and lab work, and how to navigate and choose amongst the different opportunities available to BSC students. All programs, including the supported study sessions, will be open to any student at BSC in an introductory STEM course.

Students will apply to live in the RLC, with broad selection criteria to insure a wide range of students in the RLC. To allow students to mix with students from other disciplines and to avoid isolation, the RLC will be on one floor of a multi-floor residence hall and rooms for STEM students will be assigned closest to the elevators/stairways, placing students with non-STEM majors at the end of the hall.

Two principle student affairs staff involved with the creation of the Virginia Tech community are now employed by BSC, Dr. David Ostroth (Vice President for Student Affairs) and Dr. Cathryn Turrentine (Research Analyst), making the adaptation of the Virginia Tech model to BSC substantially easier. Dr. David Ostroth and Student Affairs administrators will work with Dr. Jeffrey Williams (STREAMS co-I) to plan a RLC in year 1 and implement the community in year 2. After year 2, the community will be established, and faculty from STEM including Dr. Williams will oversee it as part of regular college duties. STREAMS will continue to provide financial support for tutoring and supplemental activities in the residence hall.

Formal objectives for the RLC are:

1. 70% of first-year community members remain within STEM the following year
2. 50% of each first-year cohort graduate with STEM degrees within six years
3. students in the RLC report a high rate of community and higher social and academic self-confidence
4. 80% of the first-year community member attend at least 2 RLC programs each semester
5. 80% of the first-year community members participate in the STEM-POE mentoring program

By participating in the POE and RLC programming, students will achieve greater awareness of the methods of STEM disciplines and the opportunities available to STEM students. Student attitudes towards science and their community will be monitored through annual surveys of students living in the RLC.

8.5: Summer Bridge Program

The primary goals for the summer program participant will be to develop increased preparation levels and be fully ready to begin as STEM majors in the fall; to develop a more detailed understanding of STEM practices by immersion in undergraduate research style projects; to develop a full-fledged peer network in advance of the fall semester; and to adjust to college-level work, expectations, and support structures through activities and an early start in the Portfolios of Excellence mentoring program (see 8.3). The summer bridge program will be administered by the Summer Bridge Team consisting of a dedicated director, the STREAMS PI, and the Director of Mathematical Services. Literature on underserved populations shows that exposure to college-level work for students with limited previous family knowledge of college opportunities and pitfalls can significantly increase success rates (Ackerman 1991; Myers, Pathways to College Network, 2003; Venezia, Kirst, and Antonio 2003; McDonough 2004).

Sixteen incoming freshman STEM majors will participate in a three-week, residential summer bridge program in August before beginning school in the fall. The first day of the summer program will be the annual August Adrian Tinsley Program Summer Undergraduate Research celebration. The incoming STEM majors would attend the research presentations of advanced students, getting a concrete idea of the work they too can accomplish.

Applicants will be screened for eligibility based on the criteria of the Project Compass target group of underserved students (low income, first generation, or students of color) with the additional criteria that their BSC placement exams place them into at least Pre-calculus (Math 100) and Writing I (English 101). Participants will take two classes for credit at no charge: Math 108: Integrated Science and Mathematics, a course that demonstrates the connectivity of mathematics and science while addressing skills, and Physics 199: First Year Seminar.

First Year Seminar (FYS) is a topical, writing intensive course in the BSC core curriculum that focuses on academic inquiry, research, and writing within a specific discipline. The summer program FYS will be titled “Scientists at Work” and will focus on introducing rigorous analytical thinking through examination of different frontiers of science. Class discussions will based on news articles from the *New York Times* science section, and class activities will teach students to apply quantitative analysis including the use of basic statistics, presentation of numerical data, etc. Students will write fifteen revised pages, of which at least ten will be in formal lab report style. The FYS will be designed and taught by the STREAMS PI, Dr. Thomas Kling of the Physics Department, who has served for the past three years as coordinator of the FYS Program.

Integrated Science and Mathematics (ISM) will be a course surveying the common mathematical underpinnings of the STEM disciplines. The aim of the course is to connect students' analytical reasoning with both their scientific understanding and their communication skills. While the content of the course will be primarily precalculus level mathematics, an equal focus will be placed on contextualizing and communicating mathematics, incorporating both simple scientific models and the students' own experimental data.

To prepare students for Math 100 (precalculus) in the short term and their STEM core courses in the long term, the ISM course will stress the importance of telling a story with mathematics. Scientists communicate mathematics in many ways - with data, graphs, formulas, and words - and the ability of students to both communicate effectively in these "mathematics languages" and translate between them will be crucial to their success in whatever their chosen analytical discipline. ISM will be designed and taught by the STREAMS Co-I, Dr. Matthew Salomone of the Mathematics Department, and Director of the Mathematics Services Center.

As a requirement of the two courses, each participant in the summer program will work in teams of four for fifteen hours per week performing undergraduate research. Each team will work under the direction of a faculty lab mentor and alongside an advanced undergraduate peer mentor who completed a summer undergraduate research projects through the Adrian Tinsley Program. Student participants in the summer program will be paid $450 for their work in the research lab to help offset time missed from working before college starts. Each team will develop a research question and project, and individual students will write a paper for the FYS based on this work. Material will be drawn from the background research, data analysis and statistics for use in Math 108. The participants will present at a program-ending banquet attended by program participants, their families, and key faculty and administration.

During the residential component of the program, a student resident assistant and residential director will structure study time and college-acclimation activities. The BSC Student Affairs staff has volunteered to provide training for the resident assistant that will include specific programming designed to help with acclimation and team building. In addition, student mentoring will begin early with the STEM-POE (see 8.3) and through a weekly seminar with faculty from the STEM departments.

The summer program represents a large expenditure of monetary resources in the STREAMS proposal, and we expect it to have a significant impact. These quantitative outcomes and targets of the summer bridge program will be measured:

1. 85% of participants achieve grades of C or higher in Math 108 and Physics 199 in the summer program
2. 75% of participants earn a cumulative 2.5 GPA in their STEM classes their first year
3. 75% of participants are retained as STEM majors from year 1 to year 2

Further, the summer program has important social goals for participants including the development of a peer network, early exposure to undergraduate research and mentoring by faculty and upper-level students, and an increase in academic and social self-confidence. Extensive surveys and the CIRP questionnaire will be used to help measure these social goals. Pre and post surveys will be used to determine changes in students’ attitudes and

understanding of the practice of science and mathematics. Summer bridge students will influence their peers in the fall semester by being better prepared and knowing about the BSC STEM culture. They will also be asked to help with recruiting STEM students to the college by making presentations at their high schools.

8.6: Transfer Student Assistance

STREAMS will assist transfer students through two initiatives led by a STEM Transfer Program Director: coordination of STEM course-content and teaching methods between BSC and the community colleges and an expansion of the BSC Transfer Student Orientation Program focusing on specific STEM opportunities for undergraduate research and internships. Previous research has demonstrated that students transferring from community colleges into four-year institutions face difficulties in adjusting to the institutional culture and the rigorous academic demands of the new institution (Laanan, F.S., 2007). In addition students often report frustration due to a lack of information about academic requirements and transferable courses at their new institution (Gonzalez, *et el*., 2008). STREAMS will enable transfer students to benefit from a smoother transition to BSC, better advising at both BSC and local community colleges, and better coordination of course content between BSC and local community colleges.

BSC has strong ties with three community colleges – Massasoit, Bristol and Cape Cod Community College – through the CONNECT consortium, a group of local public higher education institutions. In fall 2007, 410 students transferred to BSC from a Massachusetts community college, but currently the number of students transferring in STEM disciplines is about 42 per year. Unfortunately, transfer students persist at significantly lower rates in STEM than students who begin their careers at BSC.

In order to address these issues, the Transfer Student Director will develop a working group of STEM faculty at BSC, Massasoit and Bristol Community Colleges. The mission of this group will be to coordinate course content so that students entering BSC in the junior year in any STEM major will have completed lower level STEM requirements. In years 1 and 2 of the grant, annual meetings between the STEM faculty members of these institutions will discuss curricular changes in order to achieve this objective. In year 3, participating community college faculty will be trained in the STEM-POE mentoring program in order to facilitate transference of this program at the community college level. This will provide continuity for transfer students in tracking their progress during their academic career, enhancing their integration at the four-year institution. Finally, in years 4 and 5, annual meetings will focus on disseminating information to the community colleges regarding the pedagogical changes made at BSC in order to achieve inquiry-based learning (see 8.1).

New students who transfer to BSC will benefit from an expanded STEM transfer orientation program. Through the Academic Achievement Center, BSC runs a transfer student orientation program that generally describes the academic functioning of the college: the registration process, the billing process, the process for withdrawal, etc. The expansion would build upon this base in three ways. First, STEM faculty advisors would meet with each student individually and in small groups to formalize student placement. Second, faculty advisors would provide brief lab experiences that introduce transfer students to BSC's inquiry-based learning styles and the expectation level. Finally, BSC undergraduates would help explain the opportunities available to BSC STEM majors, including the availability of undergraduate research and internship opportunities. Research indicates that students who have participated in similar programs at other institutions have increased social and academic involvements leading to increased graduation rates (Laanan, F.S., 1996).

Coordination with local community colleges and expanding the orientation of transfer students will increase the number of students entering BSC as STEM majors from community colleges and allow for an increase in their retention in STEM majors. Project goals include

increasing the number of transfer students by at least 5 each year in STEM, and increasing transfer student retention in STEM from their first year to second year at BSC to 65%.

9. Broad Outcomes, Assessment, Research Questions and Dissemination

STREAMS will undergo a two-pronged assessment approach. First, each program component has specific outcomes that are designed to address identified barriers to STEM retention at BSC. These outcomes will be assessed continuously through surveys, focus groups, student performance in classes, and levels of participation. Second, STREAMS has overall goals for the retention of students from year to year and for graduation rates. The Office of Institutional Research and Assessment (OIRA) routinely collects general data regarding student retention at BSC; its efforts will be slightly expanded through STREAMS to focus on data regarding student retention within STEM. Students exiting STEM disciplines will be surveyed to determine the reasons for withdrawal from a STEM major. In addition, STREAMS and OIRA will continue to monitor the progress of the target group of low income students, first-generation students, and students of color as a separate group throughout the grant process and on each assessment mechanism.

STREAMS differs from some similar programs in its focus on traditionally underserved students and its interdisciplinary and college-wide approach. These differences present interesting research questions that we will study and report to the community:

1. To what extent does the summer bridge program help traditionally underserved students succeed as STEM majors compared to the general population?
2. What is the impact of participation in STEM-POE mentoring on student success and retention in STEM? Does STEM-POE encourage higher participation rates in undergraduate research, internships, and other markers of quality education?
3. What is the impact of living in the Residential Learning Community?
4. Does BSC replicate findings about the shift to inquiry-based and group learning assignments, particularly for low income students, first generation students, and students of color?

The assessments embedded within the interventions and the overall program assessments will be used to address these questions at key points throughout the grant. Information about BSC STREAMS will be disseminated through a website on the BSC webpage, and through participation in national and regional meetings.

10. Institutional Support and Sustainability

As an institutional effort, STREAMS relies on the support of all the STEM departments and many offices throughout the college, including the Academic Achievement Center, the Office of Institutional Diversity, the Office of Institutional Research and Administration, the Office of Teaching and Learning and the Office of Undergraduate Research. Each of these has shown a commitment to the goals and methods of this grant by contributing to the writing process.

Sustaining the STREAMS interventions will be possible at BSC. The curriculum changes, STEM-POE mentoring program, RLC, and strengthening of ties to community colleges can be maintained with minimal resources once established. The Office of Institutional Diversity and Office of Institutional Research and Assessment are committed to continued monitoring of the Project Compass target group in STEM and other disciplines beyond the period of this grant.

BSC has a history of supporting SLA-style interventions including a large array of targeted English book clubs for English 101, targeted Math 100 (precalculus) sections and extensive writing, mathematics, and communication skills centers. As the STREAMS SLA interventions are a natural outgrowth from the direction of the college, BSC is open to the possibility of continuing these after the grant period. Likewise, the summer bridge program is

similar to college initiatives (Upward Bound, for example) and will be a priority of the Office of Institutional Diversity. BSC has committed to paying for the housing of the sixteen summer program residential students and the residential staff (about $10,000 per year cost to the college) in its state-owned residence halls.

11. Grant Personnel

STREAMS will be a joint effort of all STEM departments, with participation from each department in oversight, teaching and curricular design committees. Program administration will be the responsibility of the PI, Dr. Thomas Kling. Co-Is Dr. Stephen Waratuke, Dr. Lee Torda, Dr. Matthew Salomone, Dr. Jeffrey Williams, Dr. Jenna Mendell, and Dr. Ann Brunjes will participate in one or more teams with that will oversee components and assist in assessment.

Dr. Thomas P. Kling (*Principal Investigator)* is an Assoc. Prof. of Physics and winner of the BSC 2007 Presidential Award for Outstanding Teaching. For three years, Dr. Kling has served as coordinator of the BSC First Year Seminar (FYS), leading or overseeing faculty professional development workshops that encourage use of engaged student learning and Writing-Across-the-Curriculum pedagogies. Dr. Kling leads FYS program assessment and has served on the college Assessment Guidebook Review Committee. Dr. Kling includes BSC undergraduates in his research on general relativity and has published two papers with BSC undergraduates.

Dr. Stephen Waratuke (*Summer Program Coordinator*) is an Assist. Prof. of Chemistry, where he has been central to chemistry department efforts to incorporate undergraduate research into departmental offerings. Dr. Waratuke has presented nationally on pedagogical issues in chemistry, and participated in the 2007 POGIL-NSF workshop held at the United States Coast Guard Academy in New London, CT.

Dr. Lee Torda (*STEM-POE Coordinator)* is entering her fourth year as Director of the Office of Undergraduate Research after serving 6 years in the English Department. Dr. Torda has expanded undergraduate research and mentoring opportunities at BSC through the creation of course and semester grants, the Midyear Symposium for First and Second Year Students, and the Portfolios of Excellence Mentoring Program. At the national level, Dr. Torda works as a facilitator and consultant for the Council of Undergraduate Research to help other colleges develop undergraduate research programs.

Dr. Matthew Salomone (*Supplemental Learning Assistance Coordinator*) is an Assist. Prof. of Mathematics and Computer Science and Director of the Mathematical Services. Dr. Salomone trains and directs student learning assistants attached to targeted freshmen skills mathematics and precalculus. As a teaching post-doctoral fellow, Dr. Salomone served on the University of Arizona Integrated Science Program advisory board and will bring this approach to BSC.

Dr. Jeffrey Williams (*Residential Learning Community Coordinator*) is a Prof. of Physics and winner of the 2006 Presidential Award Winner for Outstanding Teaching. He has served as physics department chair and acting Associate Dean of the College of Arts and Sciences at BSC and Chair of the National Committee on Physics in Undergraduate Education and New England Section Representative to the American Association of Physics Teachers. He has received 7 grants from state or private agencies to improve high school teaching in the region. While a graduate student in Physics at Clark University, Dr. Williams served as a residence director and was responsible for managing and supervising the operations and community development of 9 University houses (190 students), including the supervision and training of 9 Resident Advisors.

Professor Jenna Mendell (*Transfer Program Coordinator*) is Visiting Assist. Prof. of Molecular Biology and will complete her Ph.D. from Cornell University in January 2010. Since arriving at BSC in 2008, Prof. Mendell has been integral in reaching out to local community colleges and working with new and transfer biology majors. She has presented at Massasoit Community College on transfer issues and represented BSC at the statewide conference for state colleges and community colleges. Prof. Mendell created the "Biology Boot Camp" – an orientation program for new biology majors.

Dr. Ann Brunjes (*Curriculum and Grant Administration Teams)* is entering her second year as Director of Teaching and Learning (DTL) after serving 11 years as faculty and chair (for two years) in the English Department. Dr. Brunjes received the college's Dr. V. James DiNardo Award for Excellence in Teaching in 2007. As DTL, Dr. Brunjes works with departments and individuals to improve teaching practice, revise curricula and promote inclusive teaching.

Curriculum Team: Dr. Thomas P. Kling, Dr. Ann Brunjes, Dr. Matthew Salomone: 1) assist departments in curricular changes and design to implement inquiry-based learning and in utilizing Structured Learning Assistants, 2) hire and train student workers in Structured Learning Assistance, 4) coordinate the sharing of information between departments.

Summer Bridge Team: Dr. Steven Waratuke, Dr. Matthew Salomone, Dr. Thomas Kling: 1) develop curriculum for the summer bridge program, including overseeing the undergraduate research component, 2) hire and coordinate training for summer residential director and assistants, 3) hire and oversee training of undergraduate research student and faculty mentors, 4) coordinate housing and campus events for the summer program, 5) assist recruitment and selection of students to the summer bridge program, 6) teach summer program courses.

Co-Curricular Enhancement Team: Dr. Lee Torda, Dr. Jennifer Mendell, Dr. Jeffrey Williams: 1) recruit and train faculty and student peer mentors, 2) recruit participants to POE and RLC, 3) coordinate with local community colleges on transfer issues, 4) direct the STEM Transfer Student Orientation Program.

Grant Administration and Assessment Team: Dr. Thomas Kling, Dr. Ann Brunjes, Dr. Steve Waratuke: 1) work with Dr. Michael Young (Director of the BSC Office of Institutional Research and Assessment) and outside assessment consultant to collect and review assessment data, 2) oversee the coordination between interventions and college agents, 3) maintain participant records including eligibility status and participation in program activities and interface with NSF, 4) report project activities and assessment to NSF.

12. Prior NSF Support: **No members of the principle team (PI's or Co-I's) have received NSF support in the past 5 years.**