Central Indiana STEM Talent Expansion Program

Increasing the retention and persistence to graduation for science, technology, engineering, and mathematics (STEM) students is challenging. According to "The Quiet Crises," American universities are experiencing a talent "gap" in graduating the scientifically and technically talented students needed to step into research laboratories, engineering firms, software design firms, and science policy offices of the coming decade (Jackson, 2002). A National Center for Educational Statistics study of six-year graduation data indicates that nationally, 59% of STEM majors fail to complete their degree, with 21% of those changing majors to a non-STEM field (NCES, 2000 and 2009). The National Science Board's *Science and Engineering Indicators 2000* report reinforces these conclusions: STEM degrees granted today remain below levels reached in the early 1990s. Yet, the U.S. Department of Labor projects that jobs requiring technical degrees will grow to an estimated 6 million job openings by the end of the decade - the majority being in computer sciences, mathematics, medical and health technology, and engineering. Given this talent gap, it is crucial for universities to develop strategies that encourage more students to successfully complete degree programs in STEM degrees.

The **Central Indiana STEM Talent Expansion Program** proposes the creation of a central Indiana pipeline to increase the number of students from the greater Indianapolis region (central Indiana) obtaining STEM degrees, that will be sustainable after the expiration of this grant. The goals of this project are to increase the numbers of students of all demographic groups who: (1) pursue STEM academic and career pathways; (2) participate in STEM research, industry internships, and honors activities; (3) graduate with an undergraduate degree in STEM fields; and (4) transition into industry, graduate and professional programs. The program has set a target of increasing the number of STEM graduates at Indiana University-Purdue University Indianapolis (IUPUI) by 10% per year (an increase of an additional 782 STEM graduates by 2015).

I. ABOUT THE INSTITUTIONS

**IUPUI** is located in downtown Indianapolis, and is the state's only urban research university, with 22 schools offering over 200 degree programs. IUPUI has a national reputation for its involvement with the City of Indianapolis and the Indianapolis public school systems through the IUPUI UCASE center (Urban Center for the Advancement of STEM Education). Created in 1969 by Indiana legislators, IUPUI embodies the unorthodox partnership between Indiana and Purdue Universities to serve the educational needs in the largest metropolitan region of the state, representing one-fifth of the state's population. IUPUI has grown substantially in its 40-year history, becoming the third largest campus in the state, and is the only 4-year public institution of higher education in this region. More than 60% of IUPUI's 30,100 students are first-generation college attendees and 16% of its student body belongs to minority groups.

The **School of Science** (SoS) and the **School of Engineering and Technology** (SoET) are two of the three largest undergraduate schools by headcount at IUPUI: both schools award Purdue University degrees. Together the two schools are known as leaders in undergraduate STEM education. Both schools have leadership roles in implementation of Project Lead the Way (Engineering and Bio-Medical Sciences) in school districts state-wide, and faculty from both schools are principle investigators of the Indiana-STEM Resource Network. The SoS received two NSF grants for its innovation in teaching science through the Just-in-Time Teaching (JiTT) and Peer-Led Team Learning (PLTL) projects. The Math Assistance Center provides a technology-rich environment for collaborative learning, peer mentoring, and supplemental instruction for students in all levels of mathematics. The School of SoS's Project SEAM, a collaborative effort involving fifteen central Indiana school districts and five post-secondary institutions teamed to create a "seamless" transition between high school and college for all students and funded by the Lilly Endowment, Inc., has a strong record of providing science and mathematics professional development to hundreds of local high school teachers since the partnership was established in 1999.

The **Central Indiana STEM Talent Expansion Program** will collaborate with the newly chartered community college, **Ivy Tech Community College Central Indiana**, as part of the pipeline to increase the number of students graduating with STEM degrees. This collaboration between Ivy Tech and IUPUI will build on the articulation agreements and programs already established, including the creation of new seamless pathways for students pursuing STEM programs between the two- and four-year institution.
These two campuses have the largest number of African American and Hispanic students of any postsecondary institutions in the state. Moreover, the largest number of students transferring from an Indiana community college to a 4-year institution was from Ivy Tech Central Indiana to IUPUI.

The SoET has developed 2+2 articulation agreements with other institutions, allowing students at these institutions the opportunity to transition seamlessly to the ABET accredited engineering and technology programs at IUPUI. Two of these institutions are Vincennes University (a 2-year institution) and University of Indianapolis (a 4-year institution), both of which offer a pre-engineering curriculum. A similar articulation with Franklin College (near Indianapolis) is currently being created.

The SoET has partnered with Butler University, a private institution in Indianapolis, to establish the Engineering Dual Degree Program (EDDP). The EDDP allows students to study at Butler and also have access to the engineering programs at IUPUI. Completion of this program results in two degrees from both institutions. This is not a 2+2 program where students are expected to transfer after three years to IUPUI to complete their studies. Instead, the EDDP has a curriculum that integrates the engineering courses into the students’ plan of study, which allows students to be full-time residents at Butler for the duration of the program. The Central Indiana STEM Talent Expansion Program will include the EDDP and the 2+2 programs at other institutions, creating multiple academic pathways in the STEM pipeline.

II. CHALLENGES FACING THE STEM TALENT GAP AT IUPUI
Retention and persistence to graduation are particularly challenging for STEM students on urban campuses. Recognized nationally as one of the largest urban campuses in the country, IUPUI enrolls over 30,100 students, of whom 21,000 are undergraduates, with a diverse blend of traditional full-time, part-time, returning adult, and transfer students. As summarized in Table 1, most students must work at least part-time, and many have significant family obligations. Approximately 97% of students commute to campus, and many are first generation, both known factors that effect graduation success.

In addition, thousands of students each year transfer out of IUPUI to another university, and thousands more transfer in as upper classmen. In 2008, the new IUPUI undergraduate student populations was: 46% first-time full-time (FT/FT) non-international, 23% transfers, 12% returning adults, 9% non-degree seeking, 7% inter-campus transfers, 2% FT/FT international, and 1% all others. Finally, despite recent improvements in IUPUI’s admissions criteria, many students enter as “conditional admits.” Predictably, the overall campus 1-year retention rate among freshmen is much lower than our sister, IU Bloomington, and our campus 6-year graduation rate, a traditional measure of persistence, is only 32%. Although over 21,000 undergraduate students were enrolled at IUPUI in 2008, only 3,356 degrees were awarded.

Table 1: Student Profile Compared to a Traditional Campus

<table>
<thead>
<tr>
<th></th>
<th>IUPUI SoS</th>
<th>IUPUI SoET</th>
<th>IUPUI Total</th>
<th>IU Bloomington</th>
</tr>
</thead>
<tbody>
<tr>
<td>Hours employed</td>
<td>23.8 hr/wk</td>
<td>30.3 hr/wk</td>
<td>25.8 hr/wk</td>
<td>7.2 hr/wk</td>
</tr>
<tr>
<td>% New students Full-T</td>
<td>83%</td>
<td>53%</td>
<td>69%</td>
<td>96%</td>
</tr>
<tr>
<td>Top 10% HS Class</td>
<td>43.6%</td>
<td>28.8%</td>
<td>17.9%</td>
<td>31.2%</td>
</tr>
<tr>
<td>1-yr retention rate</td>
<td>79%</td>
<td>75%</td>
<td>68%</td>
<td>90%</td>
</tr>
<tr>
<td>6-yr graduation rate</td>
<td>45.9%</td>
<td>29%</td>
<td>32%</td>
<td>73%</td>
</tr>
<tr>
<td>Degrees awarded/total</td>
<td>163/1,108 (14.7%)</td>
<td>294/1,775 (16.6%)</td>
<td>3,356/21,423 (15.7%)</td>
<td>6,352/31,626 (20.0%)</td>
</tr>
<tr>
<td>undergrads</td>
<td></td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

Source: Student retention at IUPUI: Enrollment report and analysis, Fall 2008

On the plus side, IUPUI is attracting better high school graduates. The number of students from the top 10% of their class is climbing (8.5% in 2001, 17.9% in 2008). In addition, we are accepting fewer conditional admits. The number of entering students from the lower third of their class has dropped from 12% in 2001, to 3% in 2008. IUPUI can be proud of its diverse student body, part-timers and minorities, many of whom are making considerable sacrifices to work towards degree completion.

III. IUPUI IS NATIONALLY RECOGNIZED FOR FRESHMAN SUPPORT PROGRAMS
The research literature demonstrates the importance of students’ first year experience on persistence through college graduation. Typically, more than half of all students who withdraw from college do so
during their first year (Tinto, 1993). In 1997, IUPUI formed University College (UC), led by Dean Scott Evenbeck, to develop initiatives to enhance student learning and retention of freshman. For example, an incoming freshman at IUPUI is often a participant in one or more of these UC retention initiatives:

- Summer Bridge Academy – two-week-long, on-campus programs for incoming freshman
- Freshman Orientation and academic advising throughout first year
- Freshman Learning community (LC) – 91% of first semester freshman participate
- Structured Learning Assistance (SLA) – mandatory peer-led teaching and mentoring
- Supplemental Instructional (SI) – voluntary peer mentoring in selected introductory courses
- Critical Inquiry (CI) – 1 credit hour active learning sections attached to introductory courses

The Summer Bridge Academy, which began in 2001 with 18 students, served over 400 students in 2009, representing one-fifth of the entering class. The participants then move into linked learning communities. The Themed Learning Communities (TLC) program is composed of 3 or more linked courses, including an integrative first year seminar connected through an interdisciplinary theme. Annual retention, GPA, and satisfaction results have always indicated that students who enroll in both the Bridge and the TLCs are more likely to be retained, to be academically successful, and to feel positive about their experiences at IUPUI.

As a result, student GPA and one-year retention rates have increased each year since UC’s inception. IUPUI and UC have been recognized nationally for success in student learning and retention of first-year students by US News and World Report, the AAC&U, and as a Hesburgh Award recipient. In addition, IUPUI received the 2009 Outstanding Student Retention Program Award from the Educational Policy Institute (EPI) for its Summer Bridge Program and Themed Learning Communities Initiative.

While UC has made impressive improvements in the academic lives of students, it is important to remember that the traditional freshman profile (first-time/full-time) describes only 32% of IUPUI’s new students each year. Transfer students (50% of new students), enter directly into their major, often having taken the introductory courses at their former institution. Thus, a majority of students, enter IUPUI in non-traditional ways and inadvertently bypass IUPUI’s network of freshman support programs.

IV. CURRENT IUPUI STEM ENROLLMENT AND GRADUATION STATISTICS

The School of Science consists of six degree-granting STEM departments (Biology, Chemistry, Geology, Physics, Mathematics, and Computer Science; excluding Psychology), and the School of Engineering and Technology consists of five engineering degrees (Electrical, Mechanical, Computer, Bio-Medical, and Motorsport) and six technology degrees (EET, CEMT, CPET, MET, CIT, and BMET). This project will directly target students, courses, and degree completion in these STEM degrees. In a typical year, the total number of STEM majors at IUPUI is approximately 2,800. In our baseline year, 2008-09, the SoS had 1,108 and the SoET had 1,775 declared STEM majors. Table 2 shows the numbers of new students, total students, minorities, and undergraduate degrees awarded by STEM discipline.

The definition of minority for this proposal is based on the underrepresented groups in a program as compared to the population base of central Indiana. For all STEM degrees in Table 2, African American, Hispanic/Latino, and Native Americans are considered minority (excludes Asians). In addition, females are underrepresented in engineering and technology; hence, females are included in the minority count for degrees in SoET. In SoS, physics at 20%, was the only department with less than 40% female.

Science, Engineering and Technology Student Retention (Persistence) Rates: Persistence refers to students returning to campus in successive years. Student retention rates are lowest for freshman (as is the case nationally), with 79% of all freshman students in the SoS and 75% in the SoET (53% and 67% respectively of minority students) returning for a second year. The minority retention rate is lower than the overall campus level (68%) and much lower than that of IU Bloomington (90%). From the junior to senior year, there is an 83% overall retention of STEM students, and 70% for minorities. In addition, IUPUI retains about 50% of the STEM majors from freshman to graduation, 25% for minorities.
**Table 2: Undergraduate STEM Enrollments and Graduation at IUPUI, Baseline Year 2008-09**

<table>
<thead>
<tr>
<th>STEM Program</th>
<th>Direct Admits Fall 2008</th>
<th>New Transfers Fall 2008</th>
<th>Total Majors Fall 2008</th>
<th>Minorities Fall 2008</th>
<th>Graduate s 2008-09</th>
</tr>
</thead>
<tbody>
<tr>
<td>Science - Bio, Chem, Geo, Phys</td>
<td>386</td>
<td>46</td>
<td>885</td>
<td>223 (25%)</td>
<td>123</td>
</tr>
<tr>
<td>Technology - EE,CM,CP,ME,CI,BM</td>
<td>55</td>
<td>108</td>
<td>967</td>
<td>230 (28%)</td>
<td>184</td>
</tr>
<tr>
<td>Engineering - EE,ME,CPE,BME,MS</td>
<td>102</td>
<td>91</td>
<td>808</td>
<td>285 (36%)</td>
<td>110</td>
</tr>
<tr>
<td>Mathematics - Math, CS</td>
<td>48</td>
<td>15</td>
<td>223</td>
<td>42 (19%)</td>
<td>40</td>
</tr>
<tr>
<td><strong>TOTAL</strong></td>
<td><strong>591</strong></td>
<td><strong>260</strong></td>
<td><strong>2,883</strong></td>
<td><strong>780 (29%)</strong></td>
<td><strong>457</strong></td>
</tr>
</tbody>
</table>

1 includes African American, Hispanic/Latino, and Native American students, excludes Asians and females
2 includes African American, Hispanic/Latino, Native American, and female students, excludes Asians

**Science and Engineering Course Retention (DFW) rates:** the DWF rate refers to the number of students who complete the course with a grade of A, B, or C in comparison to students who receive a D, F, or withdraw. One of the primary factors in freshman attrition is the high DFW rates in freshman introductory courses. At IUPUI, science majors select from a number of different introductory courses that are required for progression to the upper division courses: Introductory Biology (K101), Chemistry (C105), Computer Sciences (CSCI 230), Engineering (196), Pre-Calculus (153 or 159), Calculus (165 or 221), Physics (P201 or 152), and Technology (104). In all instances, these courses are medium-to-large enrollment lecture-hall based courses. Looking at the breakdown for the courses below (Table 3), it is clear that there are high numbers of students who do not pass these classes successfully. This unacceptably high DFW rate is one of the main factors in our decision to revise the introductory courses.

**Table 3: Science and Engineering Course Retention rates (DFW) for introductory STEM courses**

<table>
<thead>
<tr>
<th>Department</th>
<th>Course</th>
<th>n</th>
<th>D</th>
<th>F</th>
<th>W</th>
<th>DFW Total</th>
<th>% DFW</th>
</tr>
</thead>
<tbody>
<tr>
<td>BIOL</td>
<td>K101</td>
<td>595</td>
<td>50</td>
<td>53</td>
<td>67</td>
<td>170</td>
<td>28.6</td>
</tr>
<tr>
<td>CHEM</td>
<td>C105</td>
<td>869</td>
<td>68</td>
<td>55</td>
<td>71</td>
<td>194</td>
<td>22.3</td>
</tr>
<tr>
<td>CSCI</td>
<td>230</td>
<td>157</td>
<td>8</td>
<td>31</td>
<td>12</td>
<td>51</td>
<td>32.5</td>
</tr>
<tr>
<td>ENGR</td>
<td>196</td>
<td>273</td>
<td>4</td>
<td>10</td>
<td>11</td>
<td>25</td>
<td>9.2</td>
</tr>
<tr>
<td>Pre-CALCULUS</td>
<td>153</td>
<td>1219</td>
<td>141</td>
<td>252</td>
<td>311</td>
<td>704</td>
<td>57.8</td>
</tr>
<tr>
<td>Pre-CALCULUS</td>
<td>159</td>
<td>241</td>
<td>29</td>
<td>46</td>
<td>46</td>
<td>121</td>
<td>50.21</td>
</tr>
<tr>
<td>CALCULUS</td>
<td>165</td>
<td>510</td>
<td>41</td>
<td>69</td>
<td>83</td>
<td>193</td>
<td>37.8</td>
</tr>
<tr>
<td>CALCULUS</td>
<td>221</td>
<td>317</td>
<td>21</td>
<td>49</td>
<td>43</td>
<td>113</td>
<td>35.7</td>
</tr>
<tr>
<td>PHYS</td>
<td>P201</td>
<td>232</td>
<td>12</td>
<td>20</td>
<td>30</td>
<td>62</td>
<td>26.7</td>
</tr>
<tr>
<td>PHYS</td>
<td>152</td>
<td>297</td>
<td>20</td>
<td>58</td>
<td>29</td>
<td>107</td>
<td>36.0</td>
</tr>
<tr>
<td>TECH</td>
<td>104</td>
<td>168</td>
<td>16</td>
<td>21</td>
<td>43</td>
<td>80</td>
<td>47.6</td>
</tr>
</tbody>
</table>

**STEM Programs Retention (6-year graduation) Rates:** 6-year completion of a degree program is considered a standard for comparison of institutional effectiveness, and is a final consideration to investigate. Each year, for both SoS and SoET, less than 35% of students with senior level standing will complete their degree. Only about 30% of seniors will receive their degree in their 4th year, as shown in Table 4, and two years later, less than 60% of students with senior level standing will graduate.

**Table 4: 6-Year Graduation Rate:** the percentage of students with senior level standing who complete their bachelor’s degree within 6 years of matriculation in SoS and SoET.

<table>
<thead>
<tr>
<th></th>
<th>SoS 6-year completion</th>
<th>SoET 6-year completion</th>
</tr>
</thead>
<tbody>
<tr>
<td>Part time students – Total</td>
<td>30%</td>
<td>18%</td>
</tr>
<tr>
<td>Part time students – Minority only</td>
<td>24%</td>
<td>--</td>
</tr>
<tr>
<td>Full time students – Total</td>
<td>60%</td>
<td>64%</td>
</tr>
<tr>
<td>Full time students – Minority only</td>
<td>50%</td>
<td>17%</td>
</tr>
</tbody>
</table>

Based on these IUPUI undergraduate STEM enrollment and graduation statistics, we now propose a plan to increase the numbers of students along a pipeline (a longitudinal approach that acts like a pump and not a filter in the pipeline) who persist in their progress towards graduation with STEM degrees.

V. PROGRAM’S ACTIVITES, GOALS, AND OBJECTIVES
The Rationale for Change. Clearly, STEM enrollments are strong, accounting for over 2,800 students of the 21,000 undergraduates at IUPUI. Yet, our overall graduation numbers are low. By looking at the three different aspects of student success: student retention (persistence), course retention (DFW rate), and program retention (6-year graduation rate), it is clear that we have substantial room for improvement in increasing the numbers of students who persist in their progress towards graduation in STEM degrees.

In the remainder of this proposal, we outline a strategic approach to increasing the number of STEM degrees at IUPUI by creating a STEM pipeline from pre-college through graduation and career placement. To do so, we will coordinate and dramatically expand programs that have proven to be successful at IUPUI and elsewhere. Our pipeline structure is: Pre-College== Transition to College== \(\text{STEM Curriculum}==\text{Student Services}==\text{Career Placement}\).

The primary goal of this proposal, consistent with Chancellor Bantz's vision for IUPUI (Bantz, 2003), is to increase the number of students who successfully complete STEM degrees by 10% each year for the duration of this grant. This will be accomplished by providing a continuum of efforts that directly target increased student learning, student retention and degree completion, and thus talent expansion is a continuous pipeline as shown in Table 5.

Table 5: Central Indiana STEM Talent Expansion Program Pipeline of Activities / Coordinator

<table>
<thead>
<tr>
<th>High School</th>
<th>Transition Programs</th>
<th>STEM Curriculum</th>
<th>Student Services</th>
<th>Career Placement</th>
</tr>
</thead>
<tbody>
<tr>
<td>A. Project Seed</td>
<td>B. STEM Bridge Gayle Williams, UC and CoPIs</td>
<td>F. Curriculum Dev CoPis, STEM course instructors, IUPUI Center for Teaching and Learning</td>
<td>H. Internships (CDS) Josh Killey, SoET Melissa Pohlman, SoS</td>
<td>H. Placement (CDS) to be created</td>
</tr>
<tr>
<td>Elmer Sanders, Southport HS</td>
<td>C. IVYTech Math Victoria Wacek, IVYTech Math Dept</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>D. 2+2 E/T Prgrms to be created</td>
<td></td>
<td></td>
<td></td>
</tr>
<tr>
<td></td>
<td>E. EDDP Butler Nancy Lammin, SoET</td>
<td></td>
<td></td>
<td></td>
</tr>
</tbody>
</table>

A. Project SEED: Increase the number of STEM graduates by increasing the number of students served by Project SEED, a summer research program for economically disadvantaged high school students in central Indiana.

Rationale: The Indianapolis Project SEED (Summer Experiences for Economically Disadvantaged) internship program, directed by the Central Indiana Section of the American Chemical Society in partnership with IUPUI, provides research experiences to high school students interested in science who come from either underrepresented ethnic and socioeconomic backgrounds, or who will be first generation college students. Students are placed with laboratory preceptors in the schools of Medicine and Science at IUPUI, and with local research companies. For the past few years, the participants were: 50% female, 54% African American, 17% Hispanic, and 75% came from families where neither parent had a college degree. Project SEED has demonstrated that 87% of participants went on to college and completed their degree, and 16% receiving advanced degrees. The students who participate in Project SEED are primarily from Indianapolis and tend to matriculate at institutions in central Indiana (IUPUI, Butler, and IVYTech), but also other Indiana institutions like Purdue and IU. A few of these students have been accepted at Howard, Ohio State, and Harvard.

Strategy for Talent Expansion: We will create a program that places minority students in research experiences at IUPUI while they are still in high school. This will be based on a small but successful Project SEED program currently run by a local high school chemistry teacher. Students are paid a stipend of $3,200 for the 8-week (full day) summer research experience. In 2009, there was funding for 11 students. With additional funds for stipends, the program can accommodate 5 more internships, which will require a full-time student coordinator during the two-month program.

Benchmarks used to Measure Progress: The following benchmarks will be used to measure success: (1) the number of students placed into internships each year, (2) the percent going onto college, and (3) the percent of students selecting STEM programs at IUPUI.
Outcomes Expected: Research has shown that students who participate in summer science camps and other types of research activities in middle and high school are more likely to choose a STEM degree and are four times more likely to complete a college degree. With increased funds for student stipends, we expect to increase the number of internships per year by 50% (from 11 to 16).

B. STEM Bridge Academy: Increase the number of STEM graduates by the creation of 3 STEM Bridge Academy sections and 1 Honors STEM Bridge section for incoming freshman, adapted from the successful UC Bridge program.

Rationale: Summer bridge programs are known to be an effective way to achieve first-year student success, particularly for first generation and minority students (Meyers 2003). Since 2001, UC has implemented successful two-week Bridge programs for students in several schools like: Education, Nursing, and Liberal Arts. The teaching team consists of a faculty member from the discipline, an academic advisor, a librarian, and a student mentor who work with the students to explore the major, asses their Strengths Based Assessment report, develop an individualized Personal Development Plan (PDP), review pre-requisite math skills for college level work, and participate in other activities that build successful transition into college and the major. The Summer Bridge Academy is usually linked to a Themed Learning Community in the fall semester to help build on the peer-support groups formed during the summer. In June 2009, Drs. Williams and Watt led an IUPUI team to the AACU's Greater Expectations Institute, to develop a workable plan for enhancing the program, so that it attracts as many students as possible, especially from low-income and underrepresented populations.

Strategy for Talent Expansion: We will coordinate with UC to create a STEM Bridge Academy, and work with the newly created IUPUI Honors College to create an Honor STEM Bridge Academy, to begin in 2011. The proposal's CoPIs (Hundley, Feldhaus, Gavrin, Marrs, and Watt), along with Dr. Gayle Williams, Assistant Dean of University College, and Dr. Jane Luzar, Dean of IUPUI Honors College, will develop the STEM Bridge curriculum. Joseph Thompson, Executive Director of Academic in the SoS, will coordinate and help implement the new STEM Bridge sections. Participation is set at 25 students per section. In the two weeks prior to fall semester, students in the STEM Bridge Academy will participate in newly designed activities that will include (in addition to those of the UC Bridge) college-level math, writing, and study skill development; a guided laboratory research experience; introduction to scientific literature, IUPUI's technology and library resources; plus opportunities to get acquainted with the campus, faculty, advisors, and other students. The STEP funds will allow us to develop and implement the curriculum, support half the cost of advisors for a two-week period, as well as entirely support the four student mentors throughout the Bridge Program and the fall semester. These student mentors not only participate in the two-week program, but will also serve as personal mentors to their STEM students for the first semester, meeting regularly with the students in their freshman learning community.

Benchmarks used to Measure Progress: The following benchmarks will be used to track students: 1) Academic performance - freshman GPA and DFW rate for participants, 2) NSSE survey for student engagement, 3) Focus groups to assess satisfaction with Science Summer Bridge Academy, 4) One-year retention rate, and 5) Six-year degree completion in STEM. Full details on these activities are described in the Project Assessment section.

Outcomes Expected: Research has shown that students who participate in Bridge programs: (1) have a higher freshman GPAs, (2) make more frequent use of campus services, (3) interact more frequently with faculty and students outside of class, and (4) display significantly higher first- and second-year retention rates, as well as 6-year graduation rates, relative to students who have not experienced a bridge program (Garcia 1991, Green 1994). In the entering class of 2009, there were 220 African Americans, and 30% participated in the Bridge Program. We anticipate similar gains based on the success of past Summer Bridge Academies for other schools at IUPUI. For example, IUPUI students who completed the programs in previous summers had much stronger GPAs than did their peers: average GPA was 2.9 out of 4.0, compared to 2.3 for all IUPUI freshmen; over 50% percent had a 3.0 GPA or higher; and over 20% had a 3.5 GPA or higher.
C. IVY Tech Community College Mathematics Program: Increase the number of STEM graduates by the further development and support of the Associates Degree in Mathematics and the programs articulation with the Bachelors Degree in Mathematics (and other STEM degrees) at IUPUI.

Rationale: Community college is a gateway for many students into higher education, particularly first generation and underrepresented minority students. Therefore, creating a seamless academic pathway for students, who successfully complete work at a two-year college, to transition into a four-year college is necessary for persistence (NCES, 2009). Mathematics is one of the key subjects that determines a students future success in a STEM program, so mathematics courses at community college can act as an important pump in the pipeline for STEM graduates (NAS, 2005). The difficulty is that too few students take advantage of the advanced courses at IVY Tech (a newly formed community college). With low enrollment numbers, these math courses are cancelled, making it difficult for students to complete their associate's degree.

Strategy for Talent Expansion: For this proposal, Dr. Watt will work with Dr. Wacek, Chair of the Mathematics Department at IVY Tech, and her faculty to build their associates degree program by (1) providing professional development for their faculty teaching higher level courses for the first time, (2) offering dual MATH courses at IUPUI for low enrolling courses (like linear algebra) at IVY Tech, until the numbers rise, and (3) create a combined math club between the two institutions that will share speakers, share activities, and form a larger peer group for support. The two institutions are 5 minutes apart, such that sharing resources and classes should prove an effective collaboration.

Benchmarks used to Measure Progress: The following benchmarks will be used to track students: 1) Academic performance - GPA and retention of transfers from IVY Tech into STEM programs, 2) NSSE survey for student engagement, 3) Focus groups to assess satisfaction of the transfer process and identification of program gaps, and 4) Degree completion in STEM.

Outcomes Expected: Data shows that students who transfer from IVY Tech are more likely to graduate from IUPUI than students with the same high school backgrounds who were directly admitted to IUPUI. However, the number of students who study calculus and higher-level math at IVY Tech is small, but growing, so it is difficult to offer required courses each semester. It is expected, with joint efforts between the two mathematics departments, that the number of students completing the associate’s degree in math will increase from 1 (their first in 2009) to 5 per year at the end of this project, with a majority of these students transferring to IUPUI into STEM programs, as the recently chartered IVY Tech grows in Indianapolis.

D. 2+2 Articulations with Other Institutions: Increase the number of STEM graduates by implementing a dedicated academic advisor to help build linkages and support mechanisms (a modified bridge program) with students at other institutions before they transfer to Engineering and Technology.

Rationale: In the absence of a dedicated academic advisor working proactively with perspective students at other institutions, who are considering transferring into engineering or technology after two years, makes the transfer process very intense for the transferring student. Often, many of these students do not complete the transfer process.

Strategy for Talent Expansion: We will support an academic advisor to develop linkages to students in pre-engineering programs from Franklin College, Vincennes University, IUPU-Columbus, and University of Indianapolis in order to facilitate a seamless transition into the SoET.

Benchmarks used to Measure Progress: Benchmarks used to track student success include: 1) Academic performance - GPA after transferring; 2) One-year retention rate; and 3) Three-year degree completion.

Outcomes Expected: Each year, at least 100 perspective students from pre-engineering programs begin the application process, but only about 18 to 20 students matriculate in the SoET. It is expected
that improved dedicated advising with these students while still in their pre-engineering program can result in at least a 10% increase in 2+2 students. The goal is to increase the number to 40.

E. EDDP with Butler University: Increase the number of STEM graduates by establishing peer mentoring for Butler University students in the EDDP.

Rationale: Students in the dual degree program with Butler University (private college tuition is $28,000/yr) often find it difficult to maintain their GPA required for their academic scholarship when taking the engineering course load. The current retention rate is 35% in this program. This is the primary reason given for dropping out of the program. At present, there is not a peer mentor support program targeted for these students residing at Butler.

Strategy for Talent Expansion: We will create and support 3 mentors for the EDDP students at Butler. They will be selected from the Butler students and will be trained as described in (F) below, and they will mentor freshman at Butler who are enrolled in the EDDP program.

Benchmarks used to Measure Progress: Benchmarks used to track student success include: 1) Academic performance - GPA and DFW rate; 2) Surveys and focus groups to assess student / peer leader satisfaction; 3) One-year retention rate; and 4) Six-year degree completion.

Outcomes Expected: Program retention rates should increase by 30% based on retention rate increases seen at IUPUI for implementation of PLTL in chemistry. With 130 students currently in this program, it is expected that the retention rate will increase to 45% (or an additional 13 students will be retained).

F. Curriculum and Student Learning Support Development at IUPUI: Increase the number of STEM graduates by taking dramatic new steps to expand curriculum and student learning support that will target lowering the DFW rates in STEM courses.

We will expand and implement Peer-Led Team Learning (PLTL) and Just-in-Time Teaching (JiTTe) in introductory courses throughout the STEM majors. Research has established that students who take courses that use active learning outperform students in traditional classes and develop a greater conceptual knowledge of the course content (Astin, 1993; Hake, 1998).

Rationale: PLTL has multiple benefits for student learning and retention: The PLTL concept is straightforward: recruit recent successful students from the course to serve as peer leaders that coach small student groups in a workshop setting devoted to problem-solving. Attendance is mandatory. The students and the peer leader meet together once a week for two hours. Prior to the workshop, students complete a Self Test demonstrating knowledge of required work. During the session, students complete a series of problems with the peer leader providing additional direction, not as content expert, but as an academic coach who suggests meaningful directions for problem solving and understanding concepts. The workshops usually have 8 students, allowing for individual attention. The peer leaders meet as a group for an additional 2 hours each week with the course instructor to prepare for the upcoming workshop, as well as to learn techniques for small group instruction - group facilitation skills, pedagogical techniques, and additional content knowledge.

Rationale: Just-in-Time Teaching transforms a standard lecture format course into an active learning format. JITT is an innovative method that has significant effects on student learning and retention. The idea behind JITT is to use the internet to create a continuous feedback loop between the web and the classroom. Faculty post web-based “Warm Up” assignments on the course website prior to class. Students complete the Warm Up assignments on-line within a few hours of class. The instructor previews student Warm Up responses on-line prior to class, and shows selected student responses in class to set the stage for discussion of that day’s material. This creates an interactive classroom that emphasizes cooperative learning and formative assessment (continuous feedback), and decreases the use of traditional lecture (Novak et. al 1999, Marrs and Novak 2004).
**Strategy for Talent Expansion:** The goal of PLTL. We will be expanding the PLTL program into additional courses. Chemistry currently runs PLTL, and it will continue, but this project will actively expand it into Physics, Biology and, in modified form, Math. PLTL coordinators, “Superleaders,” will be hired and trained to oversee the numerous administrative details surrounding the recruitment, training, and scheduling of peer leaders. In addition, peer leaders receive scholarship awards for their service.

**Strategy for Talent Expansion:** PLTL modification in the Mathematics Assistance Center: The CICADA and Math Critical Area Tutors (CATs). We will create an innovative and new approach to tutoring, using CATS, and this is considered an experimental intervention. Developing a traditional PLTL model for the Department of Mathematical Sciences would not be feasible, given its very large service component. Thus, the Mathematics Assistance Center (MAC) will modify the PLTL method.

For this project, the MAC will improve the retention of STEM students through the Critical Idea Context and Depth Augmentation (CICADA) program. The CICADA program, is a new concept in peer mentoring and is being developed by Patrick Frey (Math Department). The program will provide at-risk students with highly structured individual or small group tutoring that focuses on specific concepts, which the students’ persistence in STEM may depend. Five critical area tutors (CATs) will be trained and employed. Each will receive extensive training in at least one recurrent topical area: Expressions and Operations, Logical Reasoning, Function Definition and Graphing, or Rational Exponents. Each CAT will contribute to the CICADA by developing modular material for their critical area including diagnostic tests to determine the breadth and depth of a student’s knowledge and deficiency, and instructional material to facilitate a deep understanding and broad application of the critical concept.

Currently, the MAC mentors and tutors are paid from a lab fee assessed each student who registers for a mathematics course (about $45/semester). Once the CICADA proves to be a successful addition to the MAC, the Department of Mathematical Sciences has committed to absorbing the cost of the program into the MAC budget in order to sustain the program after the funding period of the grant.

**Strategy for Talent Expansion:** Our goal is to expand JITT We will create new JITT resources for Computer Science and Engineering courses, to increase student learning, and to promote the development of critical thinking, active learning and cooperative learning skills.

**Benchmarks used to Measure Progress:** Benchmarks used to track student success include: 1) Academic performance - GPA and DFW rate; 2) Surveys and focus groups to assess student/peer leader satisfaction with workshops and JiTT; 3) One-year retention rate; 4) Six-year degree completion in STEM; and 5) Learning gains and problem-solving abilities based on performance in nationally-normed semester examinations. Full details on these activities, including additional benchmarks, are described in the Project Assessment section.

**Outcomes Expected:** Given the known success of the PLTL model on student learning, retention and persistence in Chemistry, we anticipate that similar benefits will be seen in Biology, Physics, and Math. One common outcome of PLTL is that both the peer learner and peer mentor experience significant gains in learning as a result of their interaction (Whitman, 1988, Astin 1993). Peer leaders develop a deep understanding of concepts they teach to other students, enhancing their own likelihood of progress to graduation (Bargh & Schul, 1980; Benware & Deci, 1984). PLTL promotes student retention and persistence because it fosters the social integration of both students and peers into the college community (Tinto, 1993; Braxton, Sullivan, & Johnson, 1997, Cross, 1985). Another outcome is that PLTL increases the diversity of instruction within each department – given the large numbers of workshop leaders needed, about half of the workshop leaders are female, and 10% are African American. Finally, PLTL is financially cost-effective, as small group environments with a ratio of 1:8 can be accomplished for a cost far less than could be obtained by supporting an equivalent number of graduate students or lecturers. In addition, peer leaders will receive a scholarship in compensation for their service to other students. The scholarship is not only less costly than hourly pay, but it also acknowledges the contributions of peer leaders to the academic success of other students.
Course retention rates with JiTT increase as much as 30% (in Physics and Biology). JiTT has also been shown to enhance student study skills, including preparation for class, reading course materials, and preparing for exams (Marrs and Novak, 2004, Marrs et al. 2003), and has been shown to enhance student motivation (Gavrin 1999) and student learning in Biology and Physics (Gavrin 2003). Both courses will be evaluated as to the effect of JiTT on student attitudes and motivation, student study skills and student learning. In addition, the main goal for Computer Sciences is to reduce the DFW rate, by 10% each year for the duration of the grant.

G. Honors STEM Seminars: Increase the number of STEM graduates learning higher quality scientific concepts through the creation of honor STEM seminars for upper classmen and transfer students.

**Rationale:** The formation of the IUPUI Honors College at IUPUI, in the fall of 2009, offers new opportunities to target upper division students with advanced and integrative seminar courses focused on higher quality scientific concepts in the STEM areas. The opportunity for this project to create honors experiences in the STEM disciplines is timely. As the Honors Colleges expands its upper division curriculum in the STEM areas, these honors seminars will provide an integrating and timely exposure to issues and concepts unique to STEM disciplines. Specifically, the formation of STEM seminars for upper classmen will impact the quality of STEM education at IUPUI.

**Strategy for Talent Expansion:** We will create a series of honor seminars for students interested in pursuing STEM issues at a higher cognitive level, while receiving honors credit for the experience. The Dean of the new Honors College will work with faculty in the initial development of the seminars.

**Benchmarks used to Measure Progress:** Benchmarks used to track student success include: 1) Academic performance - GPAs; 2) Surveys and focus groups to assess student satisfaction; 3) Six-year degree completion of those electing to take Stem Honors Seminars.

**Outcomes Expected:** The presence of an Honors College on campus will help recruit the best students from area high schools, and with an established seminar series, many of these academically talented students will have interests in STEM. Data from IUPUI's peer institutions (other urban campuses of comparable size), shows that campuses with an Honors College report about 10% of the undergraduate students participate in honors courses and programs. Therefore, we expected by the end of the 5-year grant, 10% of our graduates (about 50 students per year) will participate.

H. Career Development Services (CDS): Increase the number of STEM graduates by implementing a Career Development Services office to assist students in obtaining internships, developing career goals, exploring alternative academic pathways, and applying for STEM careers and graduate schools.

**Rationale:** Academic success and STEM degree completion is a balance between the quality of science education and a student's ability to develop realistic academic and career plans that match a student's vision for a STEM career. Ideally, *freshman programs* provide students with the needed skills to build a strong foundation as a college student. However, it is also necessary to support the development of our students in their *sophomore year* and beyond, as they advance in academia, approach graduation, and matriculate into a STEM career or professional/graduate school.

**Strategy for Talent Expansion:** The SoS will establish a Career Development Services Office to foster a supportive, collaborative, and engaging, learning environment to assist students from academy to career. The CDS will have two main goals to increase the number of students who graduate with a science degree and pursue a STEM career.

1. **Career Planning and Development:** CDS will assist undergraduate students in developing career goals based on their advancement in their science degree program and will help assist students with finding internships, researching opportunities, job shadowing, participating in volunteer experiences and part/full-time discipline-related work, and exploring graduate school options. The CDS will also assist in writing resumes and professional school applications, and preparing for job interviews. The CDS will also promote the use of the Career Services website to be launched in 2010.
2. Development of a School of Science Internship Program: An internship or research experience that directly relates to the career goals of students is considered one of the most effective ways to attract talented undergraduates to and retain them in STEM careers. Internships provide students with real-life experiences, which enhance their academics and increase their marketability after graduation. The CDS will work with community partners to establish internships and assist students with finding an internship that is right for them. This proposal will allow students to receive college credit with fee remission and a stipend (making internships more accessible to part-time students).

Benchmarks used to Measure Progress: 1) Awareness of CDS; 2) CDS use by students / companies; 3) Internship satisfaction questionnaires and on their achievement of IUPUI's Principles of Undergraduate Learning (a set of skills that form the conceptual foundation of courses at IUPUI) in the context of their internship experience; and 4) career and professional school advising.

Outcomes Expected: By developing a strong career planning resource for students and a strong internship program, the CDS will help students establish career plans and professional relationships that will increase the proportion of STEM students who stay focused and on-track for graduation. Having a career in focus is especially important to first-generation undergraduates, which represent 54% of entering students at IUPUI. For the first year, the CDS will have a goal of placing 5 students in internships. As the CDS establishes external partners and develops more opportunities, it is expected to grow the number to a total of 60. The CDS will set a goal to make contact with students to introduce them to CDS and the new career website though a strategic marketing plan, which begins in the STEM Bridge. The CDS will also seek funding from industry and others to establish internship scholarships at a level of 15 per year, so that the program sustains itself after the expiration of this project.

VI. MANAGEMENT PLAN AND PROJECT TIMELINE

Project SEED (Watt, Sanders): Funds from this project will allow Mr. Sanders to recruit more disadvantaged high school students to participate in summer research internships, and follow up mentoring in identifying various academic pathways into STEM disciplines.

STEM Bridge Academy (Gavrin, Hundley, Luzar, Marrs, Watt): The STEM Bridge Academy, 4 per summer (including 1 for Honors), will be administered through University College as described earlier in this proposal. Co-PIs will work closely with UC and three experienced advisors in the SoS and SoET (Marcy Carlson, Nancy Lamm, and Danny King), to recruit students during freshman orientation, coordinate activities for the program, and all will be partially compensated by this proposal.

Development and Management of PLTL (Marrs, Gavrin, Frey): Drs. Marrs and Gavrin will base their new PLTL programs in Biology and Physics on the successful program in Chemistry. Recruitment and trainings for new leaders, as well as procedures for hiring and obtaining credit reimbursement, will follow Chemistry's established protocols. A new feature made possible by the funds for this proposal is that each department involved will hire one PLTL coordinator or “Super Leader.” This coordinator will help with the numerous administrative details of hiring, registering, and scheduling peer leaders.

Development and Management of JiTT (Gavrin, Marrs, Harris): At IUPUI, Just-in-Time teaching materials for the courses will be developed gradually (website, Warm Up exercises, web-based problem-solving exercises), with assistance from two JiTT coordinators each for Engineering and Computer Sciences that will be hired specifically for this purpose. Once the websites are launched, the JiTT coordinators will assist with JiTT's necessary weekly website management.

2+2 and EDDP Programs (Carlson, Lamm, King): An academic advisor partially funded by this grant will begin making contacts with students interested in 2+2 programs before transferring to IUPUI. Beginning a dialogue with these students early will ensure a successful transition between institutions. For the EDDP program, 3 mentors, supervised by Nancy Lamm, will begin implementing PLTL mentoring for Butler students.

Internships (Pohlman): The CDS office will be new in the SoS, but comes at an opportune time for this proposal. All internship positions will be coordinated through Melissa Pohlman, who's title will become "Executive Director of Student Services" as a result of this proposal. The SoS has committed continued
support for the CDS after the grant period ends.

**Project Assessment (Mzumara, Watt):** Mixed-method qualitative and quantitative measures will be employed to determine the effect of our initiatives on student learning and persistence, as described in the assessment plan.

A timeline for this project showing the implementation dates by semester for the various strategies can be found in the appendix.

**VII. BENCHMARKS FOR PROJECT SUCCESS**

Project evaluation and assessment activities for the Central Indiana STEM Talent Expansion Program will be directed by Dr. Mzumara, Director of the IUPUI Testing Center, the campus facility that provides assessment and evaluation support. Additionally, the Director of Assessment for University College (Michele Hansen) will provide support for assessing the effectiveness of the STEM Bridge Academy.

When assessing academic success programs, Barefoot (2000, 2001) urges evaluators and planners to move beyond merely measuring impacts on student retention to also including an investigation of the effects directly experienced by students: GPA, student-to-student interaction, student-to-faculty interaction, learning objectives, attitudes and behaviors, and content knowledge. Typically, programs designed with a myopic focus solely on narrow outcomes such as ‘student retention’ may obscure an understanding of program results, and downplay the overall reason for implementing such retention strategies. As such, Simpson (2002) recommends that a variety of qualitative and quantitative instruments should be used to facilitate understanding of “why” interventions produce specific outcomes.

With this in mind, Drs. Mzumara and Hansen have developed a mixed-method STEP Evaluation and Assessment Plan designed to obtain qualitative and quantitative evidence that demonstrates how well the interventions proposed promote the project’s goals and objectives (Creswell, 2002; Frechtling & Sharp, 1997; Greene, Caracelli, & Graham, 1989, Gipps & Stobart, 2003). The STEP Evaluation and Assessment Plan employs a number of **benchmarks** to assess multiple program impacts (e.g., student retention rates, course retention rates, academic achievement, degree completion rates, learning gains, student engagement levels, attitudes, and behaviors), and also to assess whether the proposed interventions have been effective (i.e., if the intended goals have been achieved). Additionally, the plan includes on-going assessment activities to ensure the programs have been implemented as planned, and to assess if critical outcomes - particularly an increase in the number of students earning STEM degrees - have been achieved. This plan provides ongoing feedback to determine what improvements can be implemented in future interventions to better serve students’ needs and enhance academic success. A brief description of the evaluation components, both formative and summative, is as follows:

**Formative evaluation** will address aspects related to **planning and implementation** of the various components of the project for purposes of making improvements in the overall implementation of the project over the duration of the grant. Formative evaluation activities will ensure that all project personnel, as well as the Advisory Committees, understand the project goals, objectives, and timelines as outlined in the proposal, and will provide ongoing feedback as to how well the program is progressing annually. The underlying program theory that provides the foundation of the formative evaluation lends insight into exactly what program components need to be developed or changed to achieve the desired outcomes, allowing substantive improvements to be made to the program based on ongoing assessment findings. **All results will be fed back to faculty investigators and to the STEP Advisory Committees so that on-going improvements can be implemented.**

**Summative evaluation** will assess the **degree to which the project goals and objectives have been met.** Important measures of this evaluation will include documentation of student successful completion of the STEM Bridge Academy and introductory STEM courses, documentation of successful implementation of proposed interventions: student participants’ academic performance; a study of best practices that sustain over time in enhancing student retention and persistence; and most importantly, increased success rates and/or graduation rates among students participating in the proposed interventions.
The following evaluation benchmarks, evaluation methodology, and outcomes, taken together, will provide valid, reliable, objective, and credible evidence of the effectiveness and utility of the proposed interventions. The respective evaluation components will culminate in a comprehensive report summarizing project evaluation findings that can be widely disseminated to provide practical, methodological, and theoretical significance in how authentic assessment techniques could be used to improve student achievement in STEM courses.

Table 7: The Evaluation and Assessment Plan: Summary of indicators/measures and evaluation protocols or data sources that will be used.

<table>
<thead>
<tr>
<th>Benchmarks Used to Measure Progress</th>
<th>Evaluation Methodology</th>
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<tbody>
<tr>
<td>1. Academic performance: GPA and DFW rates in STEM courses</td>
<td>For each intervention (SBA, PLTL, JiTT) participants will be compared to non-participants* with regard to academic performance while controlling for background characteristics (e.g., SAT scores, HS rank, gender, ethnicity).</td>
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<tr>
<td>2. National Survey of Student Engagement (NSSE) (<a href="http://www.iub.edu/~nsse/">http://www.iub.edu/~nsse/</a>) to assess six correlates of academic success</td>
<td>For each intervention (SBA, PLTL, JiTT) students will be over-sampled when the NSSE is administered. NSSE samples student opinions of active learning and collaborative learning, student-faculty interaction, a supportive campus environment, enriching educational experiences, and level of academic challenge. Responses will be compared with non-participants* to determine if there are significant differences. This survey also provides comparative data from similar urban institutions.</td>
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<tr>
<td>3. One-year student retention / persistence rates</td>
<td>For each intervention, or use of the CDS, participants will be compared to non-participants* with regard to one-year retention rates while controlling for background characteristics. For SBA, students will be monitored to ensure program completion.</td>
</tr>
<tr>
<td>4. Six-year graduation rates</td>
<td>For each intervention, or use of the CDS, participants will be compared to non-participants* with regard to degree completion and persistence rates while controlling for background characteristics (e.g., SAT scores, HS rank, gender, ethnicity).</td>
</tr>
<tr>
<td>5. Focus groups and personal interviews</td>
<td>For each intervention, or use of the CDS, post-program completion focus groups and/or personal interviews will be conducted to understand students’ experiences in the program or internship and satisfaction with experiences.</td>
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<tr>
<td>6a. Questionnaires for students who have completed interventions</td>
<td>For each intervention (SBA, PLTL, JiTT), a post-test design with a matched control group*. A pre-program assessment is not appropriate for SBA, as a first-year student would not be expected to have these connections prior to spending time on campus.</td>
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<tr>
<td>6b. Intervention-specific questionnaires</td>
<td>SBA students: questionnaires designed to assess frequency of use of campus services, and connections with faculty and other students. PLTL students: questionnaires designed to assess student satisfaction with facilitation skills, pedagogical techniques, active-learning activities, and content instruction. PLTL leaders and CATs: questionnaires designed to assess learning gains in: mastery of content, conceptual knowledge, group facilitation, and pedagogical techniques. JiTT students: Questionnaires designed to assess learning gains in: study skills, preparation for course, reading course materials, preparing for exams, student attitudes, motivation, and academic self-efficacy.</td>
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<tr>
<td>6c. CDS student questionnaires</td>
<td>Pre-Post Test design with a matched control group*. Questionnaires will be administered to participants pre-post and administered to a matched control group and will be designed to assess CDS students’ gains in: awareness of campus services, connections with faculty, awareness of career opportunities, career planning skills, STEM career understanding, and STEM career self-efficacy.</td>
</tr>
<tr>
<td>7. Performance on end of semester examinations</td>
<td>Students participating in JiTT or PLTL based courses scores will be compared with non-participants* to determine if there are significant differences in course or nationally-normed examination scores.</td>
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<tr>
<td>8. Monitoring CDS use</td>
<td>Students will be monitored to determine their use of the CDS while an undergraduate, and track them into career/professional school placement.</td>
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<tr>
<td>9. Internship Student Evaluations</td>
<td>Post-test design with no control group. Questionnaires will be administered to participants at completion and will be designed to assess students’ gains in: job performance, application of course material, completion of projects or assignments, applications of the Principles of Undergraduate Learning to internship experience.</td>
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*Note: If there is no direct control group, effect of interventions will be a comparison based on similar cohorts of students who completed equivalent courses, or programs prior to implementation of the educational interventions.

VIII. PROJECT SUMMARY
External Advisory Committee: This committee will consist of 4 external members from outside the institutions involved in this project. The members of this committee will be selected at the time the project is recommended for funding. The committee will meet within 3 months of the start of the project, and then once a year during the duration of the project.

Internal Advisory Committee: This committee will be chaired by Dr. Uday Sukhatme, Executive Vice Chancellor and Dean of the Faculties at IUPUI. The committee will meet once every semester during the duration of the project in order to provide advice and facilitate dissemination about the project throughout the participating institutions. Other members will include: Dr. Scott Evenbeck, University College Dean at IUPUI; Dr. Bart Ng, School of Science Dean at IUPUI; Dr. H. Oner Yurteven, School of Engineering and Technology Dean at IUPUI; Mike DeBourbon, School of Applied Science and Engineering Technology Dean at IVYTech Community College; John DeCoursey, Science and Mathematics Chair at Vincennes University; and Nancy Lamm, EDDP Butler University Engineering Program Advisor.

Intellectual Merit: Successful programs in student learning and retention benefit all involved, and have the additional intellectual merit of upgrading the academic reputation of the university. The primary intellectual merit of our project is to employ and assess the impact of several program-wide intervention strategies on student success, leading to higher numbers of students graduating with STEM degrees. These intervention strategies include: Project Seed (high school internships), Summer STEM Bridge Academies, peer-mentoring and academic advising support for transfer students, Peer-led Teaching and Learning and Just-in-Time Teaching, Honor seminars, and Career Development services and internships. IUPUI, with its nationally recognized commitment to improving educational success for all students, has numerous support services already in place to assist with our initiative, making it possible for us to integrate research and education on effective strategies for student learning in STEM disciplines.

Potential for success: Our team of faculty investigators is highly committed and qualified to address student success and degree completion in STEM. Several of us, including Drs. Gavrin, Marrs, and Watt currently run active research programs in science education and have been recognized campus wide and beyond for teaching excellence. Other faculty, including Andrew Harris and Tim Pierce, are the coordinators of large programs for undergraduates for which they have taken the initiative to enhance student success. Melissa Pohman comes to the SoS and CDS with experience in administration, business, and academic advising. Dr. Mzumara has extensive expertise in large-scale assessment of student performance and achievement, and will provide leadership to plan, implement, and assess all evaluation components. Increasing our chances for success are the partnerships that in some cases already exist between colleagues in this project, or by those that will naturally develop by expansion of programs like PLTL and JiTT to courses in other departments requiring the guidance of colleagues who have successfully implemented these programs.

Summary of the increases expected during the five-year grant: While many of the factors leading to student persistence and degree completion may not be directly related to academic ability, our proposal aims to ‘set the stage’ for student success as much as possible, removing barriers to learning and promoting a vision of a career in STEM. As a result, we are targeting for each year of the funding, a:

- 10% increase in the number of new and transfer students admitted to STEM majors, (targets in year five, increase of: 6 from Prj SEAM/yr, 40 from 2+2/yr, 5 from IVYtech Math/yr),
- 10% increase in the number of minorities admitted to STEM majors (an additional 23 students/year),
- 10% decrease in the DFW rates for targeted courses (particularly in MATH, CS, PHYS, and TECH),
- 15 additional students participating in internship and research experiences,
- 50 graduating seniors will have participated in honors seminars, which will result in a 10% increase in the number of students completing a STEM degree at IUPUI.

This increase in degrees, over 5 years, will result in 784 additional STEM degrees during the course of the grant, which can then be sustained by the STEM departments in future years. In addition, the CDS will allow for 60 undergraduates to be placed in paid internship or research opportunities.

Activities institutionalized as a result of the project: The STEM Bridge, which is largely funded through University College, will become permanent at the end of this grant period as part of UC’s mission. In addition, JiTT teaching will become a permanent part of the course structure in Computer Science and
ME, as this pedagogical method is exceptionally low-cost and easy to maintain once implemented. PLTL, with its scholarship-compensated mentors, will require further sources of support after this funding period; however, the PLTL program has been self funded thus far and we anticipate that funding will be available after this project. Support for the CAT mentors will be absorbed into the budget of the MAC. Finally, the formation of the CDS, as a result of this project, will make a full-time internship position a permanent feature. The Dean of the SoS is committed to sustaining the Career Development Services office through permanent funding sources at the end of this grant period. Our proposal offers paid internships for students; this feature should continue as agreements are forged with the scientific community hosting the interns. Finally, project assessment and evaluation will be an important and ongoing part of this proposal. The evaluation plan detailed above already has a number of instruments in place to begin assessment.

**Broader Impact:** Our project takes a coordinated and systemic approach to increasing undergraduate success in STEM at all levels, from pre-college, to the important first year experience, to the sophomore year and on to graduation through leadership and career development. The results of this project will be of interest to all who wish to increase student success in STEM disciplines. Dissemination of our project's results will occur through the web, peer-reviewed publications, and presentations to the local and national STEM community. Blending research on teaching and learning with the participation in teaching and training will help students from diverse backgrounds, including underrepresented minorities, experience a significant increase in both knowledge of "what works" in successful college programs. In addition, the successful result of these interventions will result in increasing the numbers of talented graduates.

Funds have also been requested for hosting a national conference/workshop at IUPUI during the fourth year of the grant, which will bring together national leaders on STEM education to share their knowledge of research and best practices. Additionally, the project personnel will showcase the work being done at IUPUI and other institutions to increase the number of students completing STEM degrees. It is expected that the workshop will attract 150 participants from engineering and science schools around the Midwest and nationally. Such a workshop can be institutionalized as an annual event under the Urban Center for the Advancement of STEM Education at IUPUI.

**IX. RESULTS FROM PRIOR NSF SUPPORT**

**WebScience: Creating an Active Learner Classroom with WWW Technology to Improve Introductory Science and Mathematics Courses.** NSF Award: DUE 998-1111 (PI A. Gavrin, Co-PI's K. Marrs, J. Watt, R. Blake) 01/1999 through 01/2001. The project is a CCLI Adaptation and Implementation project aimed at implementing the JiTT method in science courses. **Outcomes** of the project were the development of extensive web-based materials. The project has resulted in the following outcomes: **Courses affected:** 11 courses in 4 departments; **Web-based curricular materials:** Approximately 415 web-based assignments developed; **Student Impact:** Over 5000 students at IUPUI have taken courses using the JiTT method; **Assessment instruments** have been developed to assess the JiTT method and outcomes: A 44 item pre/post-course survey that measures student attitudes in 8 areas, several online mini-surveys that measure student assessment of the JiTT method, A protocol for student focus groups convened to discuss the JiTT method. **Project dissemination** has been carried out through presentations and publications: Thirty-eight talks and P.I. and Co-P.I.-led workshops, 1 book (Gavrin 2001), and the project web sites: http://webphysics.iupui.edu/webscience/webscience.html and http://www.biology.iupui.edu/biocourses/n100/archives.html. 6 peer-reviewed publications.

**Peer-led Team Learning: A Catalyst for Student Success.** NSF-funded Project, Miami University subcontract. 9/01/1999 through 8/31/01 **Overview:** The concept is to engage recent students to serve as coaches, to direct small groups towards more effective problem-solving strategies. These peers are not content experts, but are students who can suggest meaningful directions for understanding material. **Outcomes** of the project were the development of PLTL for Chemistry. Currently, 90 different sections are offered each year. This approach benefits both students and peer leaders in development of problem solving skills and conceptual understanding, plus development of leadership skills for peer leaders. **Student impact:** Over 1500 students have participated in using PLTL. The project has had success with students showing a higher level of the performance on exams (10-15% increase). The PLTL program has resulted in a 30% increase in students successfully completing the course. **Project dissemination** has been carried out through numerous presentations and publications.