AC 2007-2197: GATEWAY INTO FIRST-YEAR STEM CURRICULA: A COMMUNITY COLLEGE/UNIVERSITY COLLABORATION PROMOTING RETENTION AND ARTICULATION

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Gateway into First-Year STEM Curricula: A Community College/University Collaboration Promoting Retention and Articulation

Abstract

This paper summarizes an NSF STEP collaboration between Wright State University (WSU) and Sinclair Community College (SCC) to develop a common first-year STEM experience, which aims to increase first-to-second year retention at both SCC and WSU, as well as articulation of STEM majors from SCC to WSU. While STEM attrition is a problem throughout the 4-6 years of college study, the first-year experience (FYE) is most critical to retention of students in STEM disciplines. Thus, a focus on promoting success in the first year will help to ensure that students remain in STEM disciplines, as opposed to switching majors or dropping out. The primary barrier to success in Engineering/Technology is the mathematics "gateway" calculus sequence; the barrier to success in Science/Mathematics is general innumeracy and scientific illiteracy. Prior NSF support of WSU's National Model for Engineering Mathematics Education has shown that the introduction of EGR 101 "Introductory Mathematics for Engineering Applications," coupled with a significant restructuring of the early engineering curriculum, has resulted in a significant increase in first-to-second year retention, as well as increased student motivation and confidence in math and engineering. Based on this prior success, the current NSF STEP initiative will: 1) Implement EGR 101 and the associated engineering curriculum reforms at SCC. 2) Develop a companion lab-based class for science majors (Scientific Thought and Method), SM 101/ASE 101, for instruction at both WSU and SCC. 3) Provide professional development opportunities for faculty at both institutions. 4) Train STEM seniors/graduate students to serve as lab/recitation assistants and peer tutors for any introductory STEM classes. 5) Disseminate the curriculum and associated first-year experience. The above educational treatments will make the curriculum substantially more accessible to all incoming students, and particularly to those who have been historically underrepresented in STEM disciplines. This model is therefore highly appropriate for other metropolitan university/community college dyads with similarly diverse enrollments. While this NSF STEP initiative has only just begun, this paper will provide an overview of the motivation, goals and development to date of the program.

Background: The Quiet Crisis in STEM Education

Recent reports from industry groups[1] and governmental agencies and commissions[2-5] have drawn attention to the looming crisis in US graduation rates in the STEM disciplines. Based on the age of the STEM workforce, the US will face a future shortage of scientists and engineers if the trend of declining 2 and 4-year graduation in STEM disciplines is not reversed. While much of this discourse revolves around K-12 math and science education, significant attention also has been paid to undergraduate STEM education. Seymour and Hewitt[6] report that the interest in STEM majors among entering college students dropped from 11.5% in 1966 to 5.8% in 1988. Attrition includes students who are unprepared for the demands of STEM curricula as well as talented undergraduates who choose other disciplines with more creative instructional-delivery methods. A common challenge for K-16 is the goal of demonstrating the

wonder of discovery through constructivist approaches while assisting students in mastering rigorous content.

STEM Education at Wright State University

Founded in 1967 and located in Dayton, Ohio, WSU is a comprehensive public, doctoral, research-intensive institution of 17,000 students (13,058 are undergraduates) and 2200 faculty and staff. WSU offers more than 200 associate, prebaccalaureate (at Lake Campus), and baccalaureate degrees, and over 50 graduate and professional degree programs, including Ed.S., M.D., Psy.D., and Ph.D. degrees. The five Ph.D. programs are clustered in the STEM disciplines: biomedical sciences; computer science and engineering; environmental sciences; and human factors & industrial/organizational psychology. In a mere 40 years, WSU has risen to third among public institutions in Ohio in research expenditures (over $60 M annually); the first capital campaign has just exceeded the $100 M mark. The distinctiveness of WSU includes: Kaplan/Newsweek College Catalog's recommendation as one of 26 universities nationwide for "high level of individual attention from faculty"; and its recognized leadership in accessible programming for people with disabilities as evidenced by the recent NSF IGERT award to support a new interdisciplinary Ph D. concentration in Learning with Disability. WSU's current Strategic Plan (2003-2008) "On the Horizon, Building our Future" identifies a goal that directly relates to this project: *Enhance our distinctive learning experience to recruit and retain a diversity of students from the region and beyond.*

STEM disciplines at WSU: The NSF-supported STEM disciplines reside in two colleges: College of Science and Mathematics (COSM) and College of Engineering and Computer Science (CECS). The COSM serves 1320 undergraduates; 63% are women and 18% are minorities (Fall 2005). The most popular undergraduate majors are biological sciences and psychology (others include environmental sciences, geological sciences, chemistry, mathematics, physics and science education). COSM has averaged over $5 million per year in externally funded research over the past 5 years. The CECS serves 661 undergraduates; 16% are women and 10% are minorities. The most popular undergraduate majors are computer science and engineering, mechanical engineering and electrical engineering; other majors are biomedical engineering, engineering physics, materials science, and industrial engineering. The CECS has averaged over $5.5 million per year in externally funded research over the past 5 years. WSU has been recognized as an exemplary institution in Ohio for its pioneering efforts in science and mathematics education of pre- and in-service teachers. Faculty jointly appointed between the COSM and the College of Education and Human Services (CEHS) have developed innovative content classes for Early, Middle, and Adolescent Young Adult education. With science and math educators contributing to this project as Sr. Personnel, we hope to similarly transform the delivery of introductory gateway STEM classes at the undergraduate level.

Profile of an entering first-year WSU STEM student: WSU draws a non-traditional enrollment (mean undergraduate age 24, many are first-generation college students) primarily from the 5 adjoining counties. Since the campus was constructed to be architecturally barrier-free, there is a large population of students with disabilities. The following table documents the profile of all entering students Fall 2005 (direct and not direct from high school) excluding transfer students; these data are disaggregated for intended STEM majors in the two colleges.

Fall 05	Enrollment	Female %	Afr. Amer. %	All minor. %	ACT
WSU	2302	57.8	16.4	27.9	20.83
COSM	318	66.9	18.2	31.1	21.61
CECS	255	12.6	9.8	15.7	23.27

WSU first-year STEM retention, and 6-yr Graduation (Fall 2004-Fall 2005): WSU participates in the Consortium for Student Retention Data Exchange (University of Oklahoma's Center for Institutional Data Exchange and Analysis). Longitudinal data exist for retention from first to second year (%) for students who entered WSU intending to major in STEM disciplines ("persisters" P, reported by subgroups and "switchers" S, students who subsequently switched out of STEM). While the overall first-to-second year retention rate has remained constant over several years, the retention of students who "persist" in the STEM disciplines has dropped. More alarmingly, the drop has been precipitous for female and African American students. Moreover, students who persist in STEM majors have lower retention rates than students overall (P + S).

Cohort	P + S	P	Caucas. P	Afr. Am. P	Male P	Female P
1997	78.2	64.2	64.8	60.7	62.4	67.8
2003	77.3	58.6	60.7	40.4	61.1	53.5

Since many WSU students are non-traditional and self-supporting, the 6-year cumulative graduation rate (%) typically is used as the norm for comparative purposes. The most recent data (1997 cohort) have been reported again for persisters (P) and switchers (S). Only 30% of students who enter the STEM disciplines graduate within 6 years with a STEM major; the graduation rate is lower among African American students and women. The students who enter interested in STEM but who switch to other majors typically graduate at a rate that is, on average, 17% higher.

	Total	Caucasian	Afr. Amer	Male	Female
P + S	46.9	47.7	37.5	48.6	43.4
P	29.4	30.5	16.1	31.5	25.0

STEM Education at Sinclair Community College

Established in 1889 and located in downtown Dayton, SCC is a public, comprehensive, open admission community college offering 158 associate degree and certificate programs. With a fall 2005 enrollment of 22,555, SCC is the 2nd largest community college in Ohio[7]. SCC serves in a leadership position as an international board member of the prestigious League for Innovation in the Community College, a global catalyst for more than 700 community colleges around the world. Since 1989, SCC has received more NSF funding than any other community college in the US (31 NSF grants totaling $13.7 M). It has earned a national reputation for its high quality programs of study and work force development initiatives[8-10].

STEM disciplines at SCC: At SCC, the STEM disciplines reside in the Engineering and Industrial Technologies Division (EIT) and the Liberal Arts & Sciences Division (LAS). The EIT Division is the largest in Ohio and second largest in the nation, and ranked 16th in the number of engineering-related associate's degrees awarded in 2004[11]. The division offers a university-parallel engineering-transfer program and 36 associate degrees in engineering technology. The EIT operates the National Center for Manufacturing Education providing curriculum products, professional development, and consulting for community colleges across the country.

The LAS division has eight academic departments and an honors program. The division provides the general education requirements for transfer students planning to earn a baccalaureate degree and for students majoring in the technology associate degree programs. The division offers associates degrees of arts and of science and has articulation agreements with all major universities in the area.

Profile of an entering first-year SCC STEM student: SCC drew 68.3% of its fall 2005 enrollment from Montgomery County and 98.1% from Ohio. The mean age was 31 and 64% attended part-time. On average over 50% of all incoming students are required to take either developmental English or mathematics; the majority are first-generation college students; an estimated 40% are from underprivileged backgrounds.

Fall 2005	**Enrollments**	**Female %**	**Afr. Amer. %**	**All minor. %**
SCC	4,662	52.3	17.2	21.7
EIT	512	6.3	15.5	21.0
LAS	576	54.5	14.9	20.5

SCC enrollment, first-year STEM retention, and articulation to WSU (Fall 2004-Fall 2005):

STEM program	**Fall 04**	**Fall 05**	**Retention %**	**Transfer 04***
Associate of Science	98	51	52.0	66
Engineering Science University Parallel Majors	49	40	81.5	50
TOTAL	**147**	**91**	**61.1**	**116**

**SCC students do not need an associate degree to transfer to WSU; they can do this with any number of credits. As such, these transfer numbers are not necessarily a subset of Fall 04 SCC enrollment.*

Barriers to First-Year Success in STEM

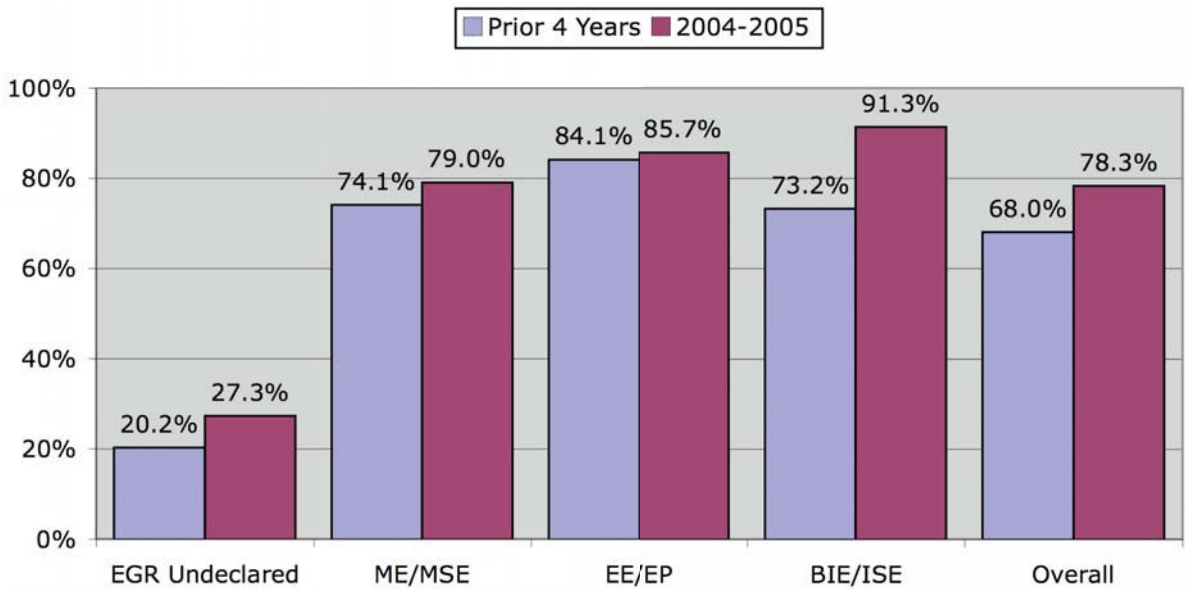
The barriers to success and persistence in STEM disciplines are complex and multifaceted[6]. Contributing factors revolve around general preparedness in mathematics and science competencies, and poor perceptions of STEM careers among K-12 students. Content delivery in "gateway" courses has been antithetical to the learning style of many students, particularly women and other underrepresented groups, compounding the problem of

representation, and access to and lack of role models. Much has been written about the "chilly" climate in the STEM disciplines that is not conducive to broadening participation. The "switchers" often include highly prepared students who seek more creative learning in an environment where they feel comfortable. In the present work, specific curricular barriers for first-year success have been identified for Engineering/Technology disciplines and for Science/Mathematics disciplines.

Barriers to first-year success in Engineering and Technology Disciplines: As discussed by Klingbeil *et al.*[12-15], one year of calculus has traditionally been a prerequisite to core engineering courses. However, only about 42% of incoming first-year students who intend to pursue engineering or computer science degrees at WSU ever complete the required calculus sequence. The remaining 58% either switch majors or leave the University. These numbers are not unique to WSU; indeed, the inability of incoming students to successfully advance through the traditional first-year calculus sequence is a primary cause of attrition in engineering programs across the country.

WSU is already receiving national attention for an innovative solution to this problem through NSF grant numbers EEC-0343214 and DUE-0618571, "A National Model for Engineering Mathematics Education." The WSU model seeks to remove the first-year bottleneck associated with the traditional calculus sequence through the development of a novel first-year engineering mathematics course, along with a substantial restructuring of the early engineering curriculum. EGR 101 "Introductory Mathematics for Engineering Applications" is taught by *engineering* faculty, and includes lecture, laboratory and recitation components. Using an application-oriented, hands-on approach, EGR 101 addresses only the salient math topics *actually used* in a variety of core engineering courses. These include the traditional physics, engineering mechanics, electric circuits and computer programming sequences. *Most importantly, EGR 101 replaces traditional math prerequisites for the above core courses, so that students can advance in the engineering curriculum without having completed a traditional freshman calculus sequence.* This has enabled a significant restructuring of the curriculum, including the placement of formerly sophomore-level engineering courses within the first year. The WSU model concludes with the development of a revised engineering mathematics sequence, taught by the math department later in the curriculum, in concert with CECS and ABET requirements. The result has shifted the traditional emphasis on math prerequisite requirements to an emphasis on *engineering motivation* for math, with a just-in-time structuring of the new math sequence.

As shown below, the initial implementation of the program has already had a dramatic effect on first-year retention in engineering at WSU. Every department requiring EGR 101 saw an increase in first-year retention in 2004-2005, as compared to baseline data averaged over the prior four years. Overall, majors requiring EGR 101 saw first-year retention increase from 68.0% to 78.3%. For this particular incoming class, this corresponds to about 15 additional sophomores in engineering. Given the flexibility of the newly restructured curriculum, it is anticipated that this initial gain will be sustained or increased as students progress in the program.



First Year Fall-to-Fall Retention for Majors Requiring EGR 101

Barriers to first-year success in Science and Mathematics Disciplines: Student preparedness (literacy and numeracy) is the major barrier for entering STEM majors at both SCC and WSU. This problem is not unique to our institutions. A recent study concluded that only 20% of students pursuing 4-year degrees had appropriate basic quantitative skills, e.g. 80% could not estimate if their car had enough gas to get to the service station.[16] In fact in that study, numeracy was a worse problem than literacy. Students enter open-admission institutions such as WSU and SCC with educational deficiencies stemming from a variety of factors. Some graduate from underperforming high schools while others enter college with academic skills diminished after years in the workforce. Almost half of incoming SCC students in Fall 2003 required developmental mathematics[17]. Likewise, at WSU 25% of entering students are placed into developmental mathematics. Unlike engineering disciplines, the mathematics requirement (typically a year of Calculus as well as elementary statistics) is not a prerequisite for entry into introductory classes in the major and does not therefore present a direct obstacle to student advancement. Yet this unremediated innumeracy may help to explain why entering students underperform in introductory science and math classes. For example, in the introductory classes for COSM intended majors (CECS majors were removed from the analysis because they tend to be better prepared students), we discovered that between 29 and 46% of students were unsuccessful (defined as D, F, X, I or W grades) in the first quarter of their first year in Fall 05.

Undergraduate math and science courses have traditionally been the burial ground for the aspirations of students, particularly underrepresented students, in the STEM disciplines. Many incoming students are underprepared in math and science and have low motivation for the coursework. Too often bridging programs merely rehearse the first-year courses without instilling enthusiasm for problem-solving and a sense of high expectations and personal achievement. Research indicates that academic success can be achieved through courses that have been redesigned to emphasize constructivist group learning rather than the competitive, isolated learning common with traditional lectures[18-19]. Students engaged in social learning settings with frequent instructor interactions consistently perform better and have higher

motivation than students in more traditional classroom settings[20-21]. In addition, inquiry-based materials that specifically address the misconceptions commonly held by students are especially effective at propelling students to success[22].

Planned New Work: Strategies to Increase STEM Majors at WSU and SCC

Objectives and Benchmarks: Wright State University (WSU) and Sinclair Community College (SCC) will collaborate on a common STEM First-Year Experience (FYE), which will effect a 10% increase in first-to-second year STEM retention and articulation from SCC to WSU. This will translate into an increase in 6-year STEM graduation rates from 47% to 54% (or an additional 50 STEM graduates per year) by the close of the project and beyond.

Student Performance Benchmarks	**2005 Cohort**
SCC first-year STEM majors	147
WSU first-year STEM majors	573
SCC annual transfer of STEM majors to WSU	116

Student Performance Benchmarks	**Current**	**Projected**	**Added STEM students per year**
SCC 1st to 2nd year retention of STEM majors	61%	**71%**	**15**
WSU 1st to 2nd year retention of STEM majors	64%	**74%**	**57**
SCC annual transfer of STEM majors to WSU	116	**+10%**	**12**
WSU graduation of STEM majors within 6 years	47%	**54%**	**50***

* Assumes 47/64=73% ultimate graduation rate of retained 2nd year and transfer students. Based on existing WSU enrollment, this will equate to an additional 50 STEM graduates per year (250 over 5 years); however if WSU is successful in growing STEM enrollment as planned, this number will equate to 73 additional STEM graduates per year (365 over 5 years). As strategies are adopted by other university/community college dyads the scale-up effect is magnified.

Adoption of EGR 101 and Associated Engineering Curriculum Reforms at SCC: SCC faculty and administration in the EIT program have agreed to adopt the EGR 101 model and associated restructuring of the first-year curriculum. EGR 101 will be required for all students planning to articulate to WSU, and will serve as a technical elective for those planning to attend another 4-year institution. It is anticipated that the first offering at SCC will require two sections of roughly 20 students each, to be cotaught by WSU and SCC Senior Personnel. The EGR 101 laboratory and recitation sections at SCC will be staffed by two undergraduate teaching assistants (UTA's) selected from among top WSU undergraduate (junior/senior level) engineering students, who will be trained by existing EGR 101 GTA's. These UTA's will serve as both mentors and role models for the SCC students. Ideally, the teaching experience afforded to UTAs will increase their own likelihood of entering a graduate program in engineering. Finally, it should be noted that the majority of the EGR 101 GTA's thus far recruited at WSU have been women; hopefully

this will translate into increasing representation of women in engineering disciplines at both institutions.

Development and Implementation of "Scientific Thought and Method" a Common Introductory Science Class Analogous to EGR 101 at both SCC (ASE 101) and WSU (SM 101)
Course Philosophy: Group discussion among interdisciplinary faculty at WSU and SCC has resulted in an agreement to develop a common introductory class that provides entering students with competency-based skills as well as a better understanding of the physical and natural sciences and how mathematics undergirds scientific inquiry. At both institutions this will replace an existing "Introduction to Science and Math" course that serves more as a standard "First-year student survival" seminar than as a source of competencies needed in the disciplines. The proposed course (4 credit hours, 3h lecture and 2 h lab) would be conceptually styled after EGR 101. It would be developed by an interdisciplinary team from both institutions and taught in small classes by faculty (not staff or academic advisors, as is common with many FYE seminars). Using the multidisciplinary case-study approach (themed around current topics like nanotechnology, environment, stem cells, artificial intelligence and robotics) the course objective would be: *to hone critical thinking and practical skills required across the sciences through executing problems and through acquiring familiarity with the scientific method.* At the same time, creative and topical-content delivery will excite students about the sciences. In the same way that EGR 101 offers a window into the engineering curriculum, SM 101/ASE 101 will offer entering students the opportunity to explore the physical and natural sciences while developing math-based skills required to succeed in the majors. Some examples might be: genetics problems requiring competency in probability; stoichiometry demanding fluency with algebra. As with EGR 101, appropriate study habits will be modeled for the students through requiring attendance and homework; the course is interdisciplinary and will articulate between SCC and WSU. The proposed new SM 101 course fulfills the learning objectives for approval as a General Education offering. This has the potential to also attract undecided students.

SM 101/ASE 101: Desired Student Learning Outcomes
The anticipated learning outcomes for SM 101/ASE 101 can be summarized as follows:
- Collect scientific data using laboratory equipment; make basic measurements and convert between units
- Analyze scientific data using quantitative skills (probability, statistics, mathematical modeling, graphical analysis, error analysis)
- Be able to design, carry out and present, orally and in writing, the results of an empirically-based scientific experiment
- Be able to maintain and organize a journal of laboratory activities
- Define misconduct in science
- Model academic ethics based upon the Wright State University Code of Ethics or the Sinclair Community College Honor Code
- Work independently and cooperatively in groups facilitated by WebCT
- Appreciate veracity of information available from different sources (peer-reviewed journals vs. internet)
- Discuss the logical and empirical basis of scientific theories, contrast scientific knowledge with non-scientific knowledge; explain real world phenomena by applying scientific principles

Major scientific concepts will be presented through interdisciplinary case studies that consider the historical context, social need/problem, natural phenomenon, and how concepts were discovered, e.g.:

- Nature of Scientific Thought (geocentric model of the Earth; gradualism vs. punctuated equilibrium; to what extent is behavior caused by biology versus more abstract psychological and social factors?)
- Science as a Process (the Wright Brothers and flight, DNA)
- Logic and Reasoning (How do we know the continents shift? How do we know subatomic particles exist? How do humans make decisions?)
- Science vs. Pseudoscience (Do species change over time? How do we know the age of the Earth? What are placebo effects in medicine?)
- Ethics in Science (Cold Fusion-what went wrong? Human clones-do they really exist? Use of human subjects and informed consent.)

Planning and Implementation for SM 101/ASE 101: The Course Development Group (CDG) will include WSU and SCC faculty from biology, physical sciences (chemistry, physics), geology, psychology, and mathematics as well as two science/math educators, who will bring to the process their knowledge of discovery-based (constructivist) learning and pedagogy, as well as content expertise. The CDG will design a *draft* course syllabus based on the desired learning outcomes, then visit every STEM department to describe and discuss merits of the course. Based on feedback from these sessions, the CDG will revise and expand the syllabus, addressing the needs of each STEM discipline. The CDG also will facilitate submission of a course request, via the University curriculum process. This process takes several months and so must begin early in 2007. Based on what we have learned from EGR 101 implementation, we expect the following curriculum adjustments:

1. SM 101/ASE 101 will be mandatory for all incoming direct-from-high-school STEM students.
2. Students will take SM 101/ASE 101 *concurrently* with their first introductory major course, beginning Fall Quarter 2007. This serves two purposes: the support system provided by the course will improve student success rates; and concurrent enrollment will prevent the need to rearrange introductory sequences, a process that would significantly disrupt departmental curricula.
3. STEM departments will make curriculum adjustments reflecting the added program requirement. In most cases, this will be accomplished through addition of SM 101/ASE 101 to each departmental introductory course-sequence and reduction of allowed free-electives.

The final planning component will be identification of 3 faculty members from the CDG (Tier One faculty) who will spend Summer quarter 2007 developing SM 101 course details, recruiting and training graduate and undergraduate teaching assistants (who also will staff the STEM Help Room), and identifying 3-4 faculty members who will receive training during 2007-08 to become SM 101 instructors (Tier Two faculty). During Summer 2007 WSU will pilot SM 101 to students entering WSU Fall 2007.

Implementation of SM 101/ASE 101 will get under way during Fall quarter 2007 with a pilot cohort of roughly 100 students at WSU. Subsequent years will include a cohort of

approximately 400 students at WSU and 100 at SCC. WSU will offer 4 lecture sections (approximately 100 students each) taught by full-time faculty and 15 recitation/lab sections of SM 101 taught by trained graduate and undergraduate teaching assistants. Tier One faculty will oversee recitation/lab sections. SCC will offer 4 sections of ASE 101, all taught by full-time faculty. Graduate and undergraduate teaching assistants trained during Summer 2007 will provide peer mentoring, tutoring, and help-room assistance. All teaching assistants will work 20 hours/week, including course teaching and ancillary support. Both WSU and SCC have identified a location for help room and related support activities. At WSU, December Intersession (4-week term between Fall and Winter quarters) will allow a second, accelerated SM 101 offering for transfer students or new students who were unable to complete it in fall.

The cycle of training additional faculty (Tier 3 and beyond) and teaching assistants will continue until a rotation of 8-10 faculty is established. Each year, a lead faculty member will receive summer salary to provide training workshops, and newly trained faculty will receive course reduction to allow time to teach the course. As a stable cadre of faculty is established, and as tuition and subsidy increasingly support continuation of the course, the need for external funding will decrease, and the course and all support functions will be *self-sustaining*. As outlined in the next section, assessment of the program and its impact on student success and retention will be continuously documented and evaluated. At this point the project focus will shift to further evaluation/assessment, and discussion of possible future programs that provide commensurate support to advanced undergraduates.

Assessment and Evaluation of Benchmarks

Assessment of these new initiatives will be aligned with existing University mandated assessment exercises and where necessary with Accreditation procedures (e.g., ABET for engineering programs). A comprehensive outcomes-based assessment program will be developed through involvement of Sr. Personnel in the area of Science and Mathematics education who are appropriately qualified to assess student learning. Learning outcomes will be identified in each class and project outcomes will be identified. Assessment measures and benchmarks will be identified. Procedures will be established for gathering the data and analysis will be undertaken that will inform program improvements. The primary objectives to be assessed are as follows:

1. STEM Expansion: Do the educational treatments identified herein result in increased first-to-second year retention at both institutions, and increased articulation from SCC to WSU? Is student learning and success in STEM enhanced?
2. STEM Model: Can a regional community college and a doctoral university partner on a common FYE curriculum? Has this partnership contributed to the STEM education knowledge-base and tangible other collaborations?

The evaluation plan will include formative (allowing for mid-course corrections) and summative measures (that assess progress towards project outcomes). Once desired outcomes have been established, short- (1-2 years) and long-term (3-5 year) indicators will be determined as well as the instruments or data sources necessary to gather the data. Quantitative measures will include ongoing archival longitudinal institutional analysis. Certain of these data already exist in the Institutional Research Office and through existing reporting of STEM success to CSRDE. Progress toward benchmarks will be compared with existing data at comparable institutions. However, additional data will be gathered, for example, whether high school ACT/SAT is a

predictor of success in the new classes and other introductory classes, and whether success in EGR 101 and SM 101 is an indicator of retention in second through 6th year or graduation rate. Data will be disaggregated by gender and race. To assess the effectiveness of these two classes pre/post science or engineering readiness test (competency based not attitudinal) will be constructed and administered. Additionally we will survey (again pre and post) students' attitudes about learning science and their motivation to continue as science majors. Appropriate statistical analysis will be performed by the WSU Statistical Consulting Center, which resides in the COSM. Qualitative measures will include surveys, interviews with students and faculty that address attitudes and motivation to continue as STEM majors, and classroom observation.

The project will be administered with input from both an Internal and an External Advisory Committee. The Internal Advisory Committee will be chaired by the Vice President for Curriculum and Instruction, and will include the 4 Deans of the respective STEM colleges (and 2 project-critical faculty from each institution. The IAC will be involved in the day-to-day monitoring of progress on the project and will meet with project faculty every 6 months.

The External Advisory Committee will be comprised of national leaders in STEM retention (for example PIs of other STEP projects), experts in the FYE (identified through the Foundations of Excellent project), experts in the area of Science and Mathematics Education (identified through faculty serving on Governor's Advisory Board for STEM education) and professional representatives from local business or industry (identified from membership of the COSM/CECS corporate boards who are familiar with the need for STEM majors in the region). The EAC will be convened within 3 months of funding and thereafter at yearly intervals. An annual meeting will take place at WSU or SCC (alternate years). At this time external evaluators will meet with the faculty and students involved in implementation and will assess progress toward reaching benchmarks identified at the start of the program.

Dissemination Plan

The curriculum for EGR 101 and SM 101/ASE 101 will be availed to other institutions through textbooks, web resources, and through presentations at meetings. Project findings will be disseminated through multiple avenues into the community of scientists, engineers and educators who collectively educate STEM students on the local, regional and national levels. Thus far WSU's engineering math reforms have been presented at multiple ASEE conferences, at Frontiers in Education and the Ohio Council of Teachers of Mathematics conferences, and at a variety of interested academic institutions. WSU/SCC strength in science and mathematics education, and also in engineering education positions us well to lead other institutions in making parallel changes as well as to publish in the educational domain. Further WSU's reputation in FYE will enable these finding to be shared broadly with other institutions seeking to enhance STEM FYE. Finally, many of the Sr. Personnel actively teach introductory classes in addition to running funded research programs, and will be able to disseminate the findings through presentations at their professional STEM associations.

Summary

This paper has summarized a recently funded NSF STEP collaboration between Wright State University and Sinclair Community College to develop a common first-year STEM experience, with the goal of increased retention, articulation and graduation rates across all STEM disciplines. The approach builds on WSU's concurrent National Model for Engineering Mathematics Education, the initial implementation of which has already resulted in a significant increase in first-year engineering retention at WSU. The current initiative will bring WSU's engineering mathematics reforms to Sinclair Community College, and will extend the approach to develop a companion first-year course for all STEM majors. The collaboration described herein is anticipated to result in no less than 50 additional STEM graduates per year by the close of the project. Moreover, the approach is designed to be readily transferable to other urban university/community college dyads with similarly diverse enrollments; as such, it has the potential for a significant scale-up effect nationwide.

Acknowledgments

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