

CENTER FOR PROMOTING STEM

A CONSISTENT AND DISTRICT-WIDE APPROACH TO INCREASE STEM ENROLLMENT AND STUDENT SUCCESS

Project Overview: Oakton Community College proposes to establish the Center for Promoting STEM (CPS), building and expanding upon successful activities developed during the past three years through DUE-0230682, to provide programs and activities for Oakton students and faculty and area high school students and teachers. Working with the nine public high schools within the Oakton district, as well as Oakton STEM students, the CPS will emphasize activities that generate interest in STEM, encourage pursuit of STEM studies among students who are traditionally under-represented in these disciplines, and strengthen the retention and success of STEM college students through their transfer to a four-year baccalaureate degree program or completion of degree or certificate STEM programs at Oakton.

Results from Current NSF-Funded Program: In 2002, the National Science Foundation awarded Oakton \$249,992 to implement a three-year project titled “Partnership to Increase STEM Enrollment and Student Success.” (DUE-0230682). This project is operating on a one-year, no-cost extension. During the past three years, in partnership with two area high school districts comprising five distinct institutions, the project PIs have developed and piloted initiatives designed to increase the number of high school students who pursue and receive degrees in STEM areas. The initiatives described herein have garnered support from industry executives, secondary school educators and peers of the PIs, with the various components reaching more than 2,000 underachieving high school and college students who have the potential to excel in STEM studies and careers. These initiatives have begun to establish Oakton’s reputation within the community and within the state community college system for its attention to math and science education.

During this project, Oakton has made the following significant accomplishments:

- The Peer Tutor Training Program won the Innovation Award of the Illinois Council of Community College Administrators (ICCCA) in 2003.
- The Student-Industry-Teacher Simulations component of the project won the ICCCA Innovation Award in 2005.
- The project treatment class, MAT052/COL101, in the Summer Bridge Program and STEM Enrichment Program, had an average success rate of 66.7%, as compared to a 60.3% overall success rate.
- Of the more than 400 students in 26 classes that included Study Sessions between fall 2003 and summer 2004, 30% participated in the Study Sessions. Among students who attended three to seven Study Sessions, 70% earned a grade of A or B. Among students who attended eight or more Study Sessions, 95% earned a grade of A or B and none received a grade of D or lower.
- 607 Oakton students have participated in the math competition of the American Mathematical Association of Two Year Colleges (AMATYC) since fall 2002, and Oakton’s rank has improved steadily, from 12th place in the Midwest region (Wisconsin, Illinois, Michigan, Indiana, Ohio and Kentucky) in fall 2002, to 2nd place out of 27 competing teams in fall 2004. Oakton’s overall standing in the country also has improved, from 87th place in fall 2002 to 28th place in spring 2005.
- The Peer Tutor Training Program trained 33 high school students as tutors certified by the College Reading and Learning Association. Almost all the high school students who took part in this program have continued studies in STEM disciplines at the university level.
- 90 students and 20 teachers from seven high schools in Oakton’s district participated in the Student-Industry-Teacher Simulations (SIT-SIMs) in 2004 and 2005.
- 105 Oakton students participated in the 2003 Summer Bridge Program and STEM Enrichment Program in 2004 and 2005. Among them, 47 received tuition reimbursement equivalent to 3 credit hours.
- 380 Oakton students have attended the CEO, Scholar and Expert Forum since 2003. Distinguished speakers at the Forum included Larry Cioffi, Senior Project Executive for IBM Global Services;

Henry Lee, Vice President and Director, Motorola, Inc. Global Software Group; Yvonne Richardson, Director of Operations for Abbott Laboratories Hospital Products Division; Dan Winslow, Vice President and Actuary, Trustmark Insurance Company; and Robert Sompolski, Oakton Chair of Mathematics & Computer Science.

- Tech-Tracks, an open house initiated by technology faculty and co-sponsored with NSERVE, the vocational and technical high school consortium, has been held every spring since 2002.
- A CD-ROM containing all the SIT-SIM modules developed to date has been distributed to area high schools and is available upon request.
- Oakton's linear algebra course, MAT260, has been accepted for credit upon transfer to the University of Illinois at Chicago.

The PIs for DUE-0230682, Tingxiu Wang, Professor of Mathematics; Gloria Liu, Math and Science Instructional Specialist; and Joseph Kotowski, Professor of Engineering and former Dean of the Mathematics and Technologies Division, continue to refine the project activities, and have been actively disseminating information about the project, including:

- The PIs, joined by Dr. Elizabeth Teles, organized a panel session titled "Advice and Admonitions on NSF Projects: What Worked, What Did Not and What Lessons Were Learned" at the Joint Annual Conference of AMS and MAA in San Antonio in 2006.
- Oakton Dean Bradley Wooten presented "The Student-Industry-Teacher Simulations" at the ICCCA fall conference, November, 2005.
- Poster sessions at the Joint Annual Conferences of the American Mathematical Society (AMS) and the Mathematical Association of America (MAA) in Atlanta, GA in January 2005.
- "The NSF Project: What Works, What Does Not and What We Have Learned" at the MAA MathFest in Providence, Rhode Island, in August, 2004.
- AMATYC 29th Annual Conference in Salt Lake City in November, 2003.
- Oakton Dean Gary Newhouse presented "Peer Tutor Training Program" at the ICCCA fall conference, November, 2003.
- Poster session at the NSF Proposal Writing Workshop in Oak Brook, IL, June 11-13, 2003.
- "How We Motivate Students to Pursue Careers in STEM" at the PKAL 2003 Assembly at Oberlin (Ohio) College, September, 2003.
- "How Can High School Students Tutor College Students," and "Promoting STEM and SML," written by the PIs, will be submitted for publication.
- Other publications and presentations are planned.

Project: In establishing the Center for Promoting STEM (CPS), Oakton will continue and expand upon the current NSF-funded project to create an institutional entity that will collaborate with other Oakton departments, Oakton faculty in STEM disciplines, area high schools, four-year postsecondary institutions, and local business and industry representatives. This collaboration will foster a sustainable increase in the number of students receiving degrees in STEM areas, as well as in the populations typically underrepresented in STEM fields, including racial and ethnic minorities, females, students from low-income families and first generation college students. Using the successful components of the current NSF project and adapting additional activities from knowledge gained and published best practices, CPS will consistently work to build an effective pipeline across the entire district that encourages younger students' interest in STEM, brings them into the postsecondary realm, provides support during their Oakton college experiences, and promotes successful transfer to a four-year program, or degree or certificate attainment. CPS also will incorporate characteristics of retention-promoting practices of community colleges (Rendon, Jalomo and Nora, 2000) such as bridge-related efforts for students who place in remedial mathematics classes, specialized mandated course offerings (including those with an orientation emphasis) early in students' CPS participation, workshops, tutoring, study groups, and a distribution of support for CPS students among a wide array of College offices and personnel. In addition,

the CPS project will work with College faculty and high school staff to address issues of retention, pedagogy and recruitment of STEM students.

Intellectual Merit and Broader Impact. Mathematics is at the root of all STEM disciplines. Improving students' mathematics skills will impact their academic confidence and ability to pursue STEM studies and careers. Concurrently, the ability to read, write, comprehend, and communicate about foundational mathematics and science concepts is also key to postsecondary STEM success. Inasmuch as this project adapts and adopts best practices in mathematics education, incorporates support services, fosters interaction with STEM professionals, and develops and pilots high-impact approaches coordinated across grades 10 through 14, the results of this project will be significant for research and practice in both secondary and postsecondary education. The Principal Director (PD) and co-Principal Directors expect that, commensurate with their success, the four major activity components will be institutionalized and extended to other schools. The Peer Tutoring component, which is a creative and original concept based on the Supplemental Instruction model but adapted by the PDs to an honors student-facilitated format, can be replicated easily in other STEM subjects such as chemistry and physics.

Students. The Hudson Institute (D'Amico & Judy: 1997) suggests that workers with solid grounding in mathematics will be in "intense" demand by employers. By contrast, enrollment in two-year college mathematics courses dropped 7.5% between 1995 and 2000, with about 55% of the students enrolling in remedial math (Conference Board of the Mathematical Sciences: 2000). It is expected that students who participate in any of the proposed project components will (1) increase their mastery of mathematical concepts, (2) become more creative and critical problem solvers, (3) improve their use of technology, including but not limited to calculators and computers as tools for learning math, and (4) be able to make connections between classroom learning and real-world experiences.

Pedagogy. The predominant instructional method for teaching mathematics continues to be the standard lecture (Conference Board of the Mathematical Sciences: 2000). The proposed SIT SIMs will develop students' inquiry, discovery, and research skills while providing a new avenue for introducing current and future teachers to an alternative model of active, inquiry-based pedagogy. These simulations capitalize on the proven impact of group-focused, contextualized, engaged learning; and they position teachers as co-learners and observers of students' learning behaviors, which may bring a fresh perspective to their teaching. Materials and support will be offered to current teachers to encourage them to incorporate new methods in their classrooms, and materials will be broadly disseminated. Locally, all project activities will forge new high school-college partnerships and faculty-to-faculty dialogs which are certain to improve understanding, articulation, and student preparation. Community colleges account for 46% of the nation's undergraduates and over half of all minorities in higher education (National Profile of Community Colleges: 2000). With this project as a model for community colleges, there is the potential to change the curriculum and pedagogy experience of nearly half of the nation's future STEM teachers, including those from underrepresented populations.

Goals and Objectives: Oakton Community College is a two-year, public, open-access institution offering baccalaureate, career and continuing education courses to a student body of nearly 10,000 credit and 30,000 non-credit students. Oakton's two campuses in Skokie and Des Plaines, IL, serve residents of the 18 ethnically, racially, religiously and socio-economically diverse communities of northern Cook County, including five public high school districts, and draw students from beyond the College's mandated boundaries, including those who reside in the City of Chicago. While feeder high schools within Oakton's district are generally considered to be above average in quality and performance, students who enter Oakton, including a large immigrant population, are nevertheless inadequately prepared for the rigors of college level mathematics courses. Approximately one-third of the high school populations fail to meet state standards in math and science on standardized tests (see Table 1 below), and the failure rates among Black and Hispanic students are significantly higher.

Results	Maine		Niles		Evanston		Glenbrook		New Trier	
Population	Math	Science	Math	Science	Math	Science	Math	Science	Math	Science
All	37.9%	32.7%	35.3%	36.9%	37.9%	40.5%	17%	25%	9.2%	12%
Black	72.5%	86.3%	66.7%	69.2%	71.3%	77.1%	not available		not available	
Hispanic	49.5%	53.8%	60.5%	64.1%	60.7%	60.7%	58.8%	55.9%	42.8%	23.8%
Asian	20%	20%	30.1%	35.6%	27.2%	27.2%	13.1%	17.1%	4.2%	5.6%

Source: Illinois 2005 District Report Cards

The statistics above are borne out by further testing at Oakton, where all students are assessed for appropriate placement before taking any math courses and before their 13th credit hour. Of 3,286 students who first tested for math placement between June 2004 and May 2005, 1,999 (61%) tested into remedial or developmental mathematics and 693 (21%) tested into an intermediate, pre-college level math course (Oakton Office of Institutional Research). It will take students at this level more semesters to earn a STEM degree, and without appropriate support services they will become discouraged, lose motivation, or find it economically unfeasible to pursue a degree or career in a STEM field.

Another barrier to success in STEM fields is limited English language proficiency. Students must be able to comprehend and notate lectures, follow directions in labs, communicate with classmates and demonstrate an understanding of the coursework in oral and written assessments. Census reports indicate that high school students residing in Oakton's district speak 79 languages other than English, and 41% of respondents to the 2004 Oakton Current Student Survey indicated that English is neither their native language nor the primary language spoken at home.

The CPS will address these issues through a four-fold approach involving **STEM Promotion, Education and Retention, Collaboration, and Evaluation and Retention**. The **goal of the project** is to increase the number of students who receive post-secondary degrees or certificates, or complete credits toward transfer to a four-year baccalaureate degree program in science, technology, engineering and mathematics (STEM) disciplines. This approach will accomplish the following objectives:

Objective 1: To increase by 7% each year of the project the number of students who pursue postsecondary STEM studies, including the study of teaching STEM, and, by the end of the grant period, to achieve an average of 200 students each year, from the current 143 students, who receive degrees or certificates or transfer in STEM programs.

Objective 2: To achieve, among students in this project's Student Enrichment Program (SEP), a success rate in Oakton's elementary algebra course that is 10% above the control group's pass rate for the same course.

Objective 3: To increase, among 85% of high school students participating in SIT-SIMs, better understanding of the application of science, math and technology in local employment fields.

Objective 4: To see high school and community college faculty participating in SIT-SIMs using an average of two additional real-world simulations, based on SIT-SIMs-type activities, in their classroom teaching the following year.

Objective 5: To conduct at least three planned dialogs each year among community college and four-year college faculty, business and industry professionals, and high school administrators and teachers that aim to strengthen pedagogy, articulation, transfer and relevant career pathways of Oakton's STEM courses and programs.

Proposed Project Design: The CPS will be located at the Des Plaines campus in space convenient to the Mathematics and Technologies Division office. CPS will be managed by a part-time coordinator and

supervised by co-PD Dr. Robert Sompolski, acting dean of the division. CPS will consist of four primary components as outlined in Table 2 below:

Promotion	Retention & Education	Collaboration	Evaluation and Dissemination
<ul style="list-style-type: none"> • Student Clubs: STEM Club and Engineering & Physics Club • CEO, Scholar and Expert Forum • WYSE • Tech Tracks • High School Outreach Activities 	<ul style="list-style-type: none"> • NSF STEM Fellowship: Study Sessions, Mentoring, STEM Enrichment Program ▪ STEM Success Seminars • STEM Internship Programs • STEM Faculty Leadership Program • SIT SIMs 	<ul style="list-style-type: none"> • Institutional Advisory Committee • Council of Industry and Academic Advisors • IL Society of Professional Engineers ▪ NSERVE • Partnership: Maine Township High School District, Niles Township High School District, Evanston Township High School District, Glenbrook High Schools • Association of Chinese Scientists and Engineers (ACSE) • Project Kaleidoscope (PKAL) • Articulation to 4-year institutions 	<ul style="list-style-type: none"> • Oakton Office of Research and Assessment • External evaluator • Presentations at professional organizations such as MAA, AMATYC, PKAL, NADE, ILADE ▪ Publications in professional journals • Oakton website • Workshops/Conferences • Semi-annual newsletter

Activity 1: STEM Promotion. STEM Promotion will be a recruitment effort at the high school and college levels. In addition to dissemination of Oakton program materials in STEM fields, promotion efforts will dispel “pocket protector”-type biases about STEM fields and increase students’ awareness of and interest in STEM disciplines through the following activities that will expose approximately 1,280 students to the world of STEM each year.

- **Student Clubs:** The STEM Club, established in 2002 and sponsored by PD Tingxiu Wang, and the Engineering and Physics Club, established in 1994 and sponsored by George Tootelian, Professor of Physics, will offer activities such as field trips, the AMATYC Math Competition, and presentations by industry professionals. As an industry hub, Chicago has myriad resources for student activities, such as the biennial International Manufacturing Technology Show. Offices of Chicago-based companies such as Abbott Labs, Allstate, Boeing, Motorola, and Argonne National Laboratories are located within 30 miles of Oakton’s campus. All of the companies contacted to date are willing to provide students with opportunities for STEM career exploration, such as site visits and speakers for STEM seminars. Dr. Wang and Mr. Tootelian will closely work with the Board of Student Affairs (BSA) to plan and organize activities. In the past three years, the BSA has provided financial support for math competition awards and for refreshments for field trips and seminars, and is willing to continue to do so.
- **The CEO, Scholar and Expert Forum:** The Forum, to be held once a semester, will increase students’ interest, understanding and knowledge in developments, opportunities and challenges in STEM fields by inviting industry executives, academic scholars, experts and politicians to present at the Forum. Previous distinguished speakers have each generously volunteered their time, and CPS will continue to invite nationally renowned speakers to the Forum. Students find the Forums interesting and informative, as indicated by the following excerpts from evaluations of one Forum:

The CEO, Scholar and Expert Forum Distinguished Speaker: Henry Lee, Vice President and Director, Global Software Service, Motorola					
N=46	Strongly Agree	Agree	No Opinion	Disagree	Strongly Disagree

The presentation increased my interest in STEM.		17	21	2	4	
The presentation increased my interest in pursuing a career in STEM.		12	19	5	5	
The presentation increased my knowledge in STEM.		12	27	3		
I will recommend the presentation to other students.		16	21	6		
How would you rate the presentation		Excellent 23	Good 20	Fair 2	N/A 1	
Sample Comments <ul style="list-style-type: none"> • Simple and easy to understand. Fun and informative. Guiding & helpful for making career decision. • Most features of presentation are very impressive and the presentation satisfied my interest. • The topic is a good choice for engineering students. The speaker was good, holds important position with respect to the topic. 						

- **Worldwide Youth in Science and Engineering Competition (WYSE):** Oakton will continue to host this annual state-wide competition for 200 high school students.
- **Tech Tracks:** Tech Tracks, an outreach as well as a recruitment effort, is a technology open house held each spring. Posters, speeches, displays and demonstrations of automation, games, tools, electronic devices and other products will be presented to approximately 300 Oakton students and high school students in the Oakton district. Student competitions will be organized and speakers from industry and business will be invited. Various NSF-funded programs, including the NSF STEM Fellowship program, STEM Internship, and SIT-SIMs, will be introduced to students.
- **High School Outreach:** Specific activities to promote STEM at area high schools will be scheduled, in an effort to pique students' interest and help them prepare for higher education and careers in STEM fields. High school students will be invited to attend the CEO, Scholar and Expert Forum, and the AMATYC Math Competition will be opened to dual enrollment students. Oakton STEM faculty will join Oakton admissions staff in making presentations each semester at district high schools to promote STEM programs and careers. Special attention will be focused on underrepresented students, particularly at those schools where concentration of an underrepresented group is especially high.

Activity 2: STEM Education and Retention. Retention efforts will focus on the longitudinal care and comprehensive education of each participant by delivering appropriate academic and support services, stabilizing student finances, evaluating student progress, and enhancing the quality of student life. According to the CBMS2000 Survey, 179 heads of community college math departments ranked "low student motivation" as the second most important issue facing math programs (Conference Board of the Mathematical Sciences: 2000). In designing academic support activities, Oakton will emphasize creating relevant learning opportunities for students at different skill levels, peer support, and using new pedagogy to increase student achievement and interest across grades 10 through 14.

- **NSF-Oakton STEM Fellowship:** The Fellowship program is a revision of previously successful components and is designed to make more effective use of student tuition rebates and enhance active peer collaboration and broader interest in STEM programs. The project will provide 60 Fellowships of \$400 each semester (\$24,000), equivalent to five credit hours, to the 10 honors students who facilitate study sessions, 20 students in the mentoring program, and to the projected 30 students who successfully complete the STEM Enrichment Program. An average of ten of these fellowships will be made available to students who pursue studies in Oakton's newly-developed Associate of Arts degree in Teaching Secondary Mathematics.
 - **Study Sessions:** The Study Sessions program is based on Supplemental Instruction (SI), a peer-assisted study model developed by Dr. Deanna C. Martin at the University of Missouri-Kansas City in 1973. Adapted by co-PI Gloria Liu, who was trained in SI in 1999, Study Sessions allow students to attend regularly scheduled, out-of-class review sessions in addition to the regular instruction and tutoring, enabling them to master course content and develop and integrate learning and study strategies. Study Sessions are offered only in tandem with courses taught by instructors supportive of the SI model. Course instructors will regularly share student grades with the Study Sessions program director.

Instructors will not know which students participate in Study Sessions, so students' grades will not be influenced.

Ten Study Sessions of two hours each will be offered for students enrolled in specific high-risk courses, including intermediate algebra, pre-calculus, calculus, college physics, college chemistry and engineering. Participation is voluntary and open to all students in the course. Times will be scheduled based on student surveys conducted during the first week of class. Assistance begins during the first week of a semester, before students encounter problems. Non-participating students will form the Study Sessions control group for each course. Study Sessions have been offered in the current NSF-funded project and have improved student success, as Table 3 below will attest:

	Term start	Term end	'C' or better	Number of A's	Success Rate	Retention Rate
MAT149, Spring '04						
Control Class	25	19	12	2	12/25=48%	19/25=76%
Treatment Class	26	21	19	9	19/26=73%	21/26=80.8%
MAT149, Fall '04						
Control Class	26	24	13	2	13/24=50%	24/26=92.3%
Treatment Class	27	28*	18	8	18/28=64.3%	28/27=103.7%
Total						
Control Classes	51	43	25	4	25/51=49.2%	43/51=84.3%
Treatment Classes	53	49	37	17	37/53=69.8%	49/53=92.5%

**A student transferred from Calculus I to this class in the 4th week.
Both control and treatment classes were taught by the same instructor and offer the most reliable results since they are not based on classes taught by two different instructors.*

While trained professional tutors have been used for the current project, Oakton's success with its peer tutoring program has led to the decision to recruit honors STEM students and train them as tutors for the Study Sessions. Honors Program director Dr. Richard Staciewicz is enthusiastic about the potential of the program, and has agreed to direct recruitment efforts. Honors tutors will participate in an intensive ten-hour training session focusing on student learning styles, instructional strategies for strengthening students' academic performance, specific teaching/learning theories and techniques, data collection, confidentiality, interacting with faculty members, and active peer collaboration in processing course materials. They will communicate with instructors frequently about course content and about issues raised by students during Study Sessions. In lieu of an hourly stipend, honors tutors will receive an NSF-Oakton STEM Fellowship and will be recognized as Fellowship recipients.

- **Mentoring Program.** Oakton's successful intervention program, *Project Succeed*, has provided ample evidence of the merits of strong mentor relationships. Since the program's inception in 1987, students on academic probation or warning have been offered a chance to stay in school provided they meet at least weekly with a faculty or staff mentor and take the College Success Seminar (COL 101) and Psychology of Personal Growth (PSY 107). Project Succeed students have averaged a mean GPA improvement of 72% after one semester's participation, while a control group's average mean improvement was 53%. Struggling and superior students alike can benefit from mentoring, and for that reason CPS's STEM Mentoring Program, based on *Project Succeed*, will be open to all students who are interested in STEM majors and careers. CPS will recruit 20 students for the program, seeking out students who are underrepresented in STEM fields. Selection criteria will include an essay on the student's interest in STEM and a personal interview. Once a student is selected for the Program, he or she will commit to (1) maintain full-time student status at Oakton for one year, (2) claim a challenging course each semester for which a mentor will be assigned, (3) keep regular appointments with the mentor to discuss the challenging course and other academic issues, (4) carry a class load each semester that includes at least one course in a STEM discipline and one course required for a STEM degree, and (5) participate in STEM activities and be willing to serve as a student club leader. Participating students will receive an NSF-Oakton STEM Fellowship for up to two consecutive semesters. Faculty mentors previously have been recruited successfully from the Mathematics and Technologies and Science and

Health Careers divisions, invited to become mentors, trained, and provided with one hour of alternative load as incentive. This process will continue to be used to obtain ten faculty members, each of whom will mentor six students.

- ***STEM Enrichment Program (SEP):*** Poor academic preparation in mathematics and English can hinder a student's pursuit of a career in STEM because he/she must take remedial classes before undertaking college-level coursework. The concept of the SEP is to combine college study skills, developmental mathematics and/or introductory English classes and intensive support in such a way that these students can catch up more quickly, rather than taking sequential remedial classes that require significant investment of time and money, and often contribute to discouragement and dropping out. SEP utilizes existing classes, but adapts them to meet the specific needs of two cohorts of 20 students each: developmental math students interested in STEM careers, and Limited English Proficient students who are advanced STEM students.

The Math Group provides students with strong academic support so they can complete the material covered in pre-algebra review (MAT051), elementary algebra (MAT052), geometry (MAT053) and intermediate algebra (MAT120) in two semesters, rather than four. Fall semester students who place in either MAT051 or MAT052 will enroll in MAT052 and College Success Seminar (COL101). COL101 is a 3-credit course that includes learning strategies, time management, career goals, computer literacy, study skills and other topics designed to increase students' success. For SEP students, contents of MAT051 will be integrated into COL101 to illustrate strategies addressed in the course. COL101 is team taught with MAT052, and uses career instructors with strong applied mathematics and technology skills. SEP students who successfully complete MAT052 and COL101 will take Intermediate Algebra (MAT120) the following spring semester. In addition, they will attend a Study Session twice a week focusing on problem solving skills and geometry (MAT053), a prerequisite of MAT120. Upon completion of MAT120, students will take the placement test to demonstrate their mastery of geometry. If they cannot pass the geometry test, they will take MAT053 in the following semester. Past SEPs have seen a 66.7% success rate, meaning 12 students will continue the program in the spring semester. Places available due to attrition will be open to other qualified students so that there still will be 20 students enrolled.

Advanced STEM students with limited English proficiency have been frustrated in their pursuit of STEM degrees and careers, as higher level college STEM courses also require advanced English abilities. The English Cohort program will strengthen students' reading and writing skills while they complete upper math or science courses, taking English 101 (EGL101) in the fall semester and English 102 (EGL102) in the spring semester. In EGL101, students will be given writing assignments that will allow them to explore their STEM career paths. In EGL102, students will write about their research on a STEM-related topic. Past English SEPs have seen a 90% success rate. English Cohort students will use their advanced STEM skills to help tutor students in the Math Group, providing the English SEP students with additional experiences to develop communication and leadership skills.

Academic course work, academic support, and advising and career counseling will be provided to all SEP students. Introducing more advanced STEM concepts into the English and College Success courses not only will address students' remedial needs but also will give students the confidence to become STEM majors. Activities also will focus on use of technology, such as TI-83 graphing calculators, to solve real-world practice problems. Business and industry representatives will help develop reality-based activities to explore concepts such as algebra, mathematical modeling, differentiation, and integration. The students will be invited to attend industry field trips and hear guest speakers' presentations about various STEM career opportunities.

Academic support for all SEP students will include one-to-one tutoring which may be provided by Peer Tutors from the STEM Internship Program, described below. Also, advisement and counseling will include one-to-one mentoring and a designated academic counselor to help students plan for baccalaureate transfer and STEM-related careers. SEP students will be expected to continue receiving tutoring until they maintain a B average GPA for two semesters. Students in this program will receive

tuition reimbursement in the form of an NSF-Oakton STEM Fellowship at the end of the semester upon successful completion of the Program. In addition, they will be invited to join the Mentoring Program.

- **STEM Internship Program:** In the current NSF-funded project, Oakton has offered a Peer Tutor Training Program, in which high school students who have completed AP Calculus are trained to tutor Oakton math students. Surveys of the Peer Tutors have indicated that, after participating in the training and tutoring, 50% are interested in a career teaching mathematics. Based on the success and popularity of the model, the CPS will offer three internship components, Peer Tutor Training, Science Lab Assistant Training, and internships available at area business and industry worksites.

- **Peer Tutor Training:** The Peer Tutor Training Program, designed for exceptional high school students, will provide experience and training in the fundamental skills essential for successful tutoring. Through readings, class discussion, case studies, journals, group work, activities and a practicum, participants will distinguish the academic and personal skills that help students achieve their academic goals. Based on the successful experience, the Program will be expanded to Chemistry, Biology and Physics. Each summer, the Peer Tutor Training component will invite six high school juniors or seniors who are National Honor Society members and/or who are taking Advanced Placement STEM courses to become Peer Tutors. An orientation and application session will clarify the roles and responsibilities of Peer Tutors and allow project staff to select the most suitable candidates. Selection criteria will include the AP class grade, GPA, recommendation of teachers, career goals and interview. Training will prepare selected candidates for tutoring STEM concepts at Oakton. Participants will receive a minimum of 10 hours of training in leadership, tutoring techniques and guidelines, role modeling, goal setting and planning, communication and listening skills, critical thinking skills, and problem solving behaviors. Project personnel will adapt materials from Oakton's College Reading and Learning Association (CRLA)-recognized college tutoring course (COL103) for the high school participants, and a professional tutor from the Oakton's Learning Center will serve as a mentor during the students' initial experiences. For their required practicum, Peer Tutors will tutor Oakton students. It is anticipated that all high school students who complete the training and practicum by tutoring for a minimum of 25 hours will be considered to have met the certification requirements of CRLA. Tutors will be paid during their practicum. In addition to assisting Oakton students who are having difficulties in STEM classes, tutors will reinforce their own learning, build leadership skills, and explore teaching STEM as a career. Research has shown that interactive, socially oriented problem-solving experiences are effective strategies for increasing student participation and continuation in STEM programs, especially for underrepresented groups (Duncan and Dick: 2000). The Peer Tutoring opportunity will infuse a social aspect into the learning process for tutors and pupils alike. In addition, Peer Tutors will participate in STEM seminars and other activities that occur during the summer.

- **STEM Lab Assistant Training Program:** Working in a science lab will expose students to careers in science and retain them in STEM fields. Oakton operates a number of labs in STEM disciplines. Each year, five Oakton students will be recruited as Lab Assistants and will receive training, participate in STEM Promotion activities, and enroll in STEM courses. Lab supervisors in Oakton's Physics, Chemistry, Biology, Engineering, and Computer Departments have agreed to mentor these students for the Program.

- **Worksite Internships:** An Illinois Cooperative Work Study Program grant will provide opportunities for qualified students to pursue paid STEM internships at area businesses and industries.

- **STEM Faculty Leadership Program:** Faculty leadership is instrumental to the quality of academic departments and programs. The STEM Faculty Leadership Program will encourage faculty involvement in Project Kaleidoscope to build leadership skills and develop teaching expertise. PD Tingxiu Wang, a Faculty for the 21st Century (F21) member since 1996, has gained significant leadership skills from his association with PKAL, which are evident from the innovative STEM activities he has organized. Each year, two STEM faculty members will be recommended for PKAL F21 membership. Besides participating in PKAL activities, they will specify an area of teaching expertise to develop and be encouraged to participate in workshops in that area. Each faculty member will then be provided three credit hours alternative time to integrate what they have learned into the curriculum. They also will be

expected to continue developing leadership skills and teaching expertise. In five years, they will be expected not only to improve teaching skills, but also demonstrate leadership and expertise by publishing papers and organizing or coordinating workshops or special sessions at conferences. Each of them will develop two modules to demonstrate specific concepts in STEM that can be used by colleagues. In five years, this program will foster a cadre of ten faculty members with excellent teaching and leadership skills and produce twenty teaching modules that will enhance teaching STEM courses. Such a strong cohort will be instrumental in sustaining STEM retention.

- ***Student-Industry-Teacher Simulations (SIT-SIMs)***: Possibly the most successful component of the current NSF project has been the SIT-SIMs. The proposed SIT-SIMs will continue to offer educators new approaches and materials to strengthen STEM instruction in high school and community college settings. Collaborating teams of industry professionals and Oakton faculty members will develop these hands-on, contextualized learning modules for use by high school student-teacher teams. Each curriculum module will be documented and distributed to participating high school teachers for use in their classrooms and also will be used by community college faculty.

Each student-teacher team will address, using foundational science and mathematics skills and concepts, the real-world problems presented by the industry professional and community college faculty member. Industry professionals also will share personal experiences with students about their career paths and how they apply STEM knowledge on the job. High school teachers are asked to select students who have potential to become postsecondary STEM majors but who may not yet have the academic confidence, motivation or external support to enter such programs upon graduation, and to make a special effort to invite females and students from other underrepresented groups to participate.

SIT-SIMs will be held on a Saturday during the spring semester to accommodate students' and teachers' schedules. Oakton is an approved provider of Continuing Professional Development Units for Illinois high school teachers and will award teachers the appropriate units for their participation, as well as provide appropriate stipends. Project personnel will follow up with high school teachers and with Oakton colleagues to learn how the SIT-SIMs have been adapted for classroom use and integrated into science, math and technology curricula. They also will provide support, if requested. SIT-SIMs will occur at least four times during the grant period, once in each spring semester (excluding the first spring semester, unless funding is available from current NSF project). Over the five-year grant period, project staff will develop 16 to 20 simulations with the assistance of partners in industry. Currently envisioned work-based mathematics scenarios include the application of mathematical functions conducted by an insurance company actuary, a mechanical design engineer, and a circuit board technologist. When designing modules, project staff will consider (1) relevance of content to the daily lives of students, (2) equipment (both multimedia and laboratory) availability and compatibility with the environments of area high schools, (3) content corresponding to the high schools' advanced STEM courses, and (4) incorporation of active, collaborative and work-based learning simulations. Each module will incorporate pedagogy that is active and research-oriented and contains both individual and collaborative tasks. Teams will be asked to define the problem or goal, backtrack from that goal to determine the steps necessary for a successful outcome, assign roles and tasks within the group, research available information, complete individual tasks, reach a conclusion, and compile and present results.

Because industry professionals and Oakton faculty will co-lead each simulation, high school teachers will have the opportunity to become co-learners with their students, allowing students to take the lead in defining and addressing the problem, supporting students as peers, and giving teachers the chance to closely observe how students approach and solve problems in this new learning environment. Teachers can use what they learn about how students perform the simulation to adapt their teaching when they return to the classroom. High school teachers and Oakton faculty will have an opportunity to debrief about the learning process and to discuss classroom application of the simulations. The Oakton-industry teams will develop a teacher's guide for each simulation that will provide the design background, a thorough description of the learning activities, and teaching strategies. The guides will be distributed to participating teachers for use in their classrooms.

In 2004 and 2005, SIT-SIMs involved more than 90 high school students and 20 high school teachers. The project's external evaluator provided the following feedback about SIT-SIMs:

- Students were very positive toward the SIT-SIMs sessions that were offered.
- Students especially liked the hands-on nature of the programming and the “real-world” feel to the sessions in which they participated.
- Students believed that the SIT-SIMs sessions increased their interest in STEM, increased their confidence in learning those subjects, and increased their interest in possibly pursuing a STEM career.
- Most of the student participants would recommend the sessions to other students.
- Teachers overwhelmingly agreed the SIT-SIMs sessions were beneficial to themselves and their students.
- Instructors of the SIT-SIMs were viewed as highly knowledgeable and competent.

Activity 3: STEM Collaboration. To ensure effective collaborations, an Institutional Advisory Committee and a Council of Industry and Academic Advisors will provide input for implementing project activities and other support. The advisory committees to the current NSF funded project have provided valuable input and support from a variety of perspectives.

The Institutional Advisory Committee will include the following Oakton personnel: Nancy Prendergast, Chair of the Committee, Acting Vice President of Academic Affairs; Donna Younger, Director of the Learning Center; Cheryl Warmann, Director of Student Financial Assistance; Dennis Graham, Dean of Science and Health Careers; Maurice Archer, Director of Accounting Services; Jim Kostecki, Manager of Research and Assessment; Cliff Casey, Manager of Advising and Counseling; Dale Cohen, Admissions Specialist; Majid Ghadiri, Associate Professor of Electronics and LAN; Carole Shapero, Professor of Mathematics; Connie Churchill, Professor of Chemistry; Terry Trobec, Professor of Biology; Michele Reznick, Professor of Computer Technologies and Information Systems; and John Carzoli, Associate Professor of Physics. The Council of Industry and Academic Advisors will consist of high school teachers and administrators, representatives from business and industry, faculty from four-year colleges and universities, and the external evaluator.

The collaborative planning and evaluation will involve Oakton and its high school partners to ensure the main activity components are effective for high school and community college faculty, students, and environments, and to ensure consistency in the project's approach. It also will facilitate evaluation and strengthen the high school-college partnership. Outreach and recruitment will include traditional and non-traditional strategies. Brochures, news articles, and direct or joint mailings to students and parents will be coupled with classroom presentations, visits to high school counselors, professor-teacher contacts, Math Dialogs, and other methods suggested by the Institutional Advisory Committee and the Council of Industry and Academic Advisors, or during collaborative planning sessions. Strong collaborations will keep the Project Directors current with best practices to enhance the project activities and improve project outcomes.

Efforts to strengthen articulation and transfer from high school to Oakton to baccalaureate institutions will occur throughout this project. The process will begin in the Math Dialogs that will support and be supported by this project, with the potential for developing similar Science Dialogs. It will continue in all four main project components and in the evaluation plan that includes strategies for tracking participants who transfer into baccalaureate programs, even if they do not first obtain an Oakton degree. Oakton will hold dialogs with four-year institutions about potential development of baccalaureate capstone programs such as the one it pioneered with Illinois Institute of Technology for its technology students who earn an A.A.S. degree. Oakton also will seek to forge new articulation agreements with the universities to which large numbers of Oakton STEM students transfer. The university representatives on the Council of Industry and Academic Advisors will be instrumental in achieving this objective.

Activity 4: STEM Evaluation and Dissemination

Evaluation Plan. Evaluation activities will be coordinated by the PD, Dr. Tingxiu Wang, with the support of Oakton's Office of Institutional Research and Assessment, and the external evaluator. (Oakton used an external evaluator on DUE-0230682, and currently is soliciting bids for an external evaluator for the proposed project.) They will include both configuration verification and value analysis. Products to be evaluated include but will not be limited to the Study Session Program, the Mentoring Program, the STEM Enrichment Program, the Internship Program, the Faculty Leadership Program and the SIT-SIMs and their associated teacher guides. All products and activities will undergo a reiterative and structured testing process to identify areas of concern and suggest improvements that will increase the effectiveness of the various design elements. Student, teacher, peer tutor and faculty data will be collected through surveys, pre- and post-testing, formal observations, focus groups and data records. The configuration verification process will check that the key design components are included and function as planned. This phase also will answer questions regarding product usefulness such as:

- Are real-world experiences effectively built into the learning content to make it meaningful and relevant?
- What concepts or theories need to be explained and are they sequenced so as to optimize students' understanding of mathematical or scientific principles?
- Are the materials understandable and user-friendly for the target?
- Does the activity effectively address the desired learning objective?

Value analysis will be incorporated into a summative evaluation that will measure the extent to which the project achieves its stated objectives. Both quantitative and qualitative information will be collected to evaluate the project's impact on student learning and teacher pedagogy. Oakton's Office of Institutional Research will provide ongoing assistance in the collection and analysis of data, a process enhanced by the installation of a new computer system at Oakton, to assess students' mastery of the subject matter as well as attitudinal changes toward and interest in STEM programs. This will be accomplished in the following manner:

PROJECT OBJECTIVES AND EVALUATION METHODS

Objective 1: To increase by an average of 7% each year of the project the number of students who pursue postsecondary STEM studies, including the study of teaching STEM, and, by the end of the grant period, achieve an average of 200 students each year, from the current 143 students, who receive degrees or certificates or transfer in STEM programs.

- Surveys will be conducted to measure changes in attitudes toward STEM subject matter, postsecondary study of STEM, careers as STEM teachers, and other STEM careers.
- All project participants will be tracked using the College's student information management system to determine in which Oakton courses they enroll, what grades they receive, and what programs they complete.
- Quantitative data on student participation in all three activity components will be collected, including, but not limited to: the number of students trained as Peer Tutors, the number of students they tutor and hours tutored; the number of students in internship experiences; the number of students and teachers participating in SIT-SIMs; the number of students participating in the STEM Enrichment Program, the number of credit hours they attempt and complete; the number of faculty mentors, the number of students mentored and the number of mentoring contacts; and STEM Club activities and participants.
- Student participants will be tracked beyond Oakton each fall, with a benchmark established in fall 2005, to determine whether they enroll in baccalaureate programs and what majors they select. Tracking methods will include: telephone and mail surveys, National Student Clearinghouse Enrollment Search data, and the Illinois Shared Enrollment File and Shared Degree File.
- Project staff will survey students to gather opinions about project activities; e.g., how peer tutoring helped them learn; whether SIT-SIMs enhanced their ability to relate content to real-world problems.

Objective 2: To achieve, among students in this project's Student Enrichment Program (SEP), a success rate in Oakton's elementary algebra course that is 10% above the control group's pass rate for the same course.

- Using the College's student database, compare Elementary Algebra (MAT 052) scores of SEP students with College average as represented by the control group in the same course.

Objective 3: To increase, among 75% of high school students participating in SIT-SIMs, better understanding of the application of science, math and technology in local employment fields.

- Pre- and post-simulation surveys and evaluations will be incorporated into each simulation and also will be conducted at the end of each SIT-SIMs workshop day to discover students' understanding of math and science concepts and their real-world applications.
- Student evaluations will reveal the extent to which students believe they learned from and were satisfied with the new approaches compared to traditional approaches.
- During the debriefing session, participating high school teachers will reflect on and assess the quality of their students' presentations.
- Participant data will be collected.

Objective 4: To see high school and community college faculty participating in SIT-SIMs using an average of two additional real-world simulations, based on SIT-SIMs-type activities, in their classroom teaching the following year.

- Participating high school and Oakton faculty will be surveyed in writing, by phone, electronically and/or in focus group interviews to determine the extent to which SIT-SIMs are incorporated into high school and college classroom teaching, to determine the number of students exposed to the new pedagogy, and to discover the experiences of faculty and students relative to these new approaches.
- Four SIT-SIMs workshops will be conducted during the project to help faculty understand how to incorporate real-world simulations into their current curriculum.

Objective 5: To conduct at least three planned dialogs each year among community college and four-year college faculty, business and industry professionals, and high school administrators and teachers that aims to strengthen pedagogy, articulation, transfer and relevant career pathways of Oakton's STEM courses and programs.

- Formal and informal meetings will be held with community college and university STEM faculty and administrators, high school administrators and teachers, and business and industry professionals, agendas presented, and results recorded.
- Data from the Illinois Shared Enrollment files will help identify to which universities Oakton STEM students transfer in greatest numbers, and those will be targeted first; however other innovative avenues also will be explored and contact logs and meeting notes kept.

Dissemination: Project personnel will use the following avenues to disseminate project information.

- ***Publications:*** It is anticipated that each year at least one article will be prepared for publication regarding either SIT-SIMs or the design and implementation of the Peer Tutor Training Program and be submitted for publication in a professional journal such as the Journal of Developmental Education, Science Education, or Journal of College Science Teaching.

- ***Presentations at Local, Regional or National Meetings:*** Project staff will disseminate project methods and results through presentations to high school and community college faculty, counselors and administrators. Additionally, at least one presentation will be made at a regional or national meeting of the National Association of Developmental Education, College Reading and Learning Association, the American Association of Higher Education, MAA, AMATYC or NCTM.

- ***Internet:*** The current project information has been available at <http://servecc.oakton.edu/nsf-stem/>, and is undergoing major redesign. Dr. Wang has been the AMATYC website coordinator since 2003, and his expertise will enhance dissemination of Oakton's project through the Internet.

- **Conferences:** Oakton will host a conference at the end of each academic year for 25 mathematics and STEM career community college faculty, high school teachers and other professionals in the Chicago area. Regional dissemination will be facilitated by Oakton’s proximity to a cluster of sister institutions – there are 20 community colleges with a cumulative enrollment of more than 180,000 students within a 50-mile radius of Oakton’s Des Plaines campus. Sessions will (1) explain the concept of collaborative situational simulations; (2) present sample situational simulations; (3) offer opportunities for discussion of issues and innovations in STEM instruction; and (4) distribute project materials and guidelines. Each faculty participant will receive a stipend for participation in the 5-hour conference, and an additional stipend if (s)he subsequently makes use of the process to develop his/her own situational simulation, uses it in the classroom, and distributes it, notifying the PDs of the method of dissemination. PDs will regularly follow up with conference participants to assess the value of the information presented and if they are utilizing the materials.

- **Newsletters:** In the past three years, the PD and co-PDs sent an annual letter to advisory committee members, high school districts, high school math and science chairs, industry contacts, NSF program officers, and other project supporters. This effort will be continued on a semi-annual basis. Recipients also will include federal and state legislators in Oakton’s district.

Project Management

Individual	Department	Role	Responsibilities	% time
Dr. Tingxiu Wang	Professor, Mathematics	PD	Overall management, STEM Club, CEO Forum, Faculty Leadership, Co-Chair advisory committees, OCC STEM website	45%
Dr. Robert Sompolski	Dean, Mathematics & Technologies (Acting)	Co-PD	Fiscal Oversight, Institutional collaboration	5%
Joe Kotowski	Professor, Engineering	Co-PD	SIT-SIMs, faculty outreach, WYSE, Tech Tracks, mentoring	45%
Gloria Liu	Instructional Specialist Math and Science	Co-PD	Study Sessions, SEP, Peer Tutor, Leadership	25%
Coordinator (to be hired)	Division of Mathematics & Technologies	Staff	CPS contact, recruiting students, assigning and supervising facilitators for study sessions, arranging faculty mentors, processing students’ records, developing project brochures, flyers, and posters, working with the external evaluator on project evaluation, monitoring work by student and clerical workers.	100% of part-time position

In addition, partners and collaborators will be responsible for the following:

<ul style="list-style-type: none"> • Partnership: Maine, Niles, and Evanston Township High School District • Participants: New Trier and Northfield Township High School Districts 	<ul style="list-style-type: none"> • Support high school teachers to develop & participate in SIT-SIMs and serve on Council of Industry & Academic Advisors. • Encourage students to participate in SIT-SIMs and STEM activities held at Oakton. • Assist in distribution of project materials. • Support Oakton’s efforts to recruit STEM students.
<ul style="list-style-type: none"> • Institutional Advisory Committee • Council of Industry and Academic Advisors • IL Society of Professional Engineers ▪ NSERVE • Association of Chinese Scientists and Engineers (ACSE) • Project Kaleidoscope (PKAL) 	<ul style="list-style-type: none"> • Advise PDs on project activities • Help identify and invite industry professionals for SIT-SIMs and distinguished speakers for the CEO, Scholar and Expert Forum. • Provide information on education and STEM. • Provide students with opportunities to visit company sites. • Provide leadership training for involved faculty. • Advise and assist Oakton’s outreach and articulation efforts. • Assist in procuring external funding to continue project after grant.

Oakton will provide space and support services for project activities. The College’s Accounting Office will ensure that grant expenses and payments are properly recorded in the College’s automated accounting system and will handle expenditures, verifying vouchers against invoices and updating the computerized expense records monthly. The College’s Grants Office will provide additional fiscal oversight and will handle grant modifications as necessary to accurately reflect the scope of the project. Institutional Research will provide ongoing assistance from the start of the project to assure assessment tools are accurate and appropriate. The Institutional Advisory Committee and the Council of Industry and Academic Advisors will offer input and provide support.

Project Timeline

TABLE 4: PROJECT TIMELINE															
	F06	Sp07	S07	F07	Sp08	S08	F08	Sp09	S09	F09	Sp10	S10	F10	Sp11	S11
STEM PROMOTION															
Student club activities															
Math competition															
CEO/Scholars Forum															
Field trips															
STEM Success Seminars															
WYSE															
Tech Tracks															
STEM EDUCATION AND RETENTION															
NSF STEM Fellowship															
Study Sessions															
Mentoring Program															
SEP															
Peer Tutors															
Recruit															
Train and implement															
Internships															
Recruit															
Place															
STEM Faculty Leadership															
Recommend for PKAL															
Attend activities, develop & implement modules															
SIT-SIMs															
Recruit & develop															
Implement															
STEM COLLABORATION															
Inst. advisor committee mtgs.															
Council of I & A advisors															
STEM EVALUATION AND DISSEMINATION															
STEM web site															
Conference															
Newsletter															
Annual Report to the NSF															