PROJECT SUMMARY

The purpose of this proposal is to increase interest in majoring in Science, Technology, Engineering or Mathematics (STEM) among non-STEM majors. To date, most programs have focused on the high switch-out rate among those initially interested in STEM. The NSF and Carnegie (Quantway and Statway) are spending millions to remedy this. A radically different approach may be required.

An analysis of data shows that 40% of those who graduate with a STEM major switched in from a non-STEM major. This project focuses on increasing that switch-in number with students that are math proficient. Of the first year students at four year colleges, 59% are math proficient (above 60th percentile). Of those who are math proficient, 55% are not interested in STEM.

The goal is to increase interest in STEM among non-STEM majors who are math-proficient.

Our proposal envisions a "new doorway to STEM with gentler steps" focusing on those who may prefer English over algebra (many of these are women) and those with weak English skills (e.g., ESL) that may interfere with their ability to succeed in a STEM major.

This will be accomplished by creating a new Science-Skills minor: a science-workforce skills curriculum. It involves six existing courses with some enhancements. The six courses include [1] problem based Excel with an introduction to macros and Visual Basic programming or an entry-level computer science course, [2] Statistical Literacy (reading and interpreting everyday statistics in tables, graphs, surveys, studies and clinical trials), [3] Philosophy of Science (examining the strengths and weaknesses of manipulative experiments and randomized trials enhanced to include observational studies and simulations), [4] A laboratory science course, [5] an observational science course (c.f., epidemiology, geology, anthropology) and [6] a science skills course (c.f., technical writing, communication, critical thinking or logic.

For non-STEM majors, this minor provides a new doorway to investigate STEM. The goal is to increase their confidence in their ability to handle a STEM challenge and increase their interest in taking more STEM courses or switching to STEM entirely.

Of these six courses, the one involving the most enhancements is statistics. At Augsburg, Statistical Literacy involves critical thinking about numbers: how context can influence a statistic or a statistical association. See Schield's (2004) paper in AAC&U Peer Review.

This proposal focuses strongly on rapid dissemination. This will be needed if PAKL is to meet its goal of influencing 100,000 students. The online training will be disseminated via www.StatLit.org (run by the project PI) with almost 200,000 visits in 2013.

Assessment in this project will have two components: internal (how many students take this minor at Augsburg) and external (how many colleges adopt this minor and how many students do they influence). Internal goal: to sign up 30 students to sign up for this new Science-Skill minor in three years. External goals: to train 100 faculty to teach this statistical literacy course and for 5 institutions (200 students) to have adopted this PKAL Science-Skills minor within three years. The ten-year goal is 70 schools and more than 2,000 students.

Promoting this PKAL Science-Skills minor is a natural fit with the AAC&U Values Rubrics for Critical Thinking, Quantitative Literacy and Written Communications.

PROJECT NARRATIVE

Introduction:

The purpose of this proposal is to increase interest in STEM among non-STEM majors, specifically among women and students where English is a Second Language (ESL). Unlike traditional approaches to STEM retention and increasing representation among historically underrepresented groups that focuses on current STEM majors, this proposal will utilize a new doorway to STEM that allows non-STEM students to explore and gain confidence in STEM in a meaningful way.

Table 1 shows that Computer Science is tied with Engineering in female under-representation.

Table 1

	US Bachelor's Degrees: 2009-2010							
STEM	# Degrees	White	Black	Hispanic	Asian	Other	Female	%Degrees
Computer Sc.	39,589	67%	12%	7%	9%	5%	18%	3%
Engineering	72,654	69%	4%	7%	12%	7%	18%	5%
Mathematics	16,030	72%	5%	6%	10%	6%	43%	1%
Physical Sc.	23,379	74%	6%	5%	11%	5%	41%	1%
SUB-TOTAL	151,652	70%	7%	7%	11%	6%	24%	10%
College-wide	1,563,069	72%	10%	8%	7%	4%	59%	100%
Source: 2011 Digest of Education Statistics, Table 301. National Center for Education Statistics								
Tables 295, 296. 2012 US Statistical Abstract					College-wide: 2008			

One way to increase STEM graduates is to focus on the high switch out (dropout) rates among first-year STEM majors (Table 2: Left side) and to advocate improving retention. Women and blacks have the highest switch-out rate. However math proficiency is a stronger predictor of STEM success than either race or gender. The switch-out/retention focus ignores the switch-ins shown in Table 2-right: *40% of those getting STEM degrees started in non-STEM majors*. This proposal focuses on the switch-in contribution – especially among those with high math scores.

Women need to be more interested in STEM in order to consider a switch; ESL students need to become more proficient in using technical English before they will switch to a STEM major.

Table 2:

A. Pctg of these 1st year students who start in STEM
B. Pctg of these 1st yr who start and graduate in STEM
C. Pctg of these STEMers who switch out of STEM*

Two & Four Year	A	B	C
All	13%	6%	54%
White	12%	6%	50%
African-American	14%	5%	64%
Men	17%	9%	47%
Women	8%	3%	63%
Top math quartile	23%	15%	35%

Carnavale (2011) Table 6. * includes college dropout

A. Pctg of these 1st yr who start and graduate in STEM
B. Pctg of these 1st yr who start non-STEM & grad STEM

Two & Four Year	A	B	TOTAL
All	6%	4%	10%
White	6%	5%	11%
African-American	5%	3%	8%
Men	9%	5%	14%
Women	3%	3%	6%
Top math quartile	15%	6%	21%

Carnavale (2011) P. 46 & 47, Tables 6 and 7 combined

Table 3 classifies students by their math proficiency and their interest in STEM. Consider just the upper-left corner: those interested in STEM and proficient in math: 24% of four-year students (8% of two-year students). These students would have a high likelihood of success in STEM if

given the opportunity to experience and develop confidence in STEM. For Table 3 detail, see BHEF (2006, 2010, 2011-08, 2011-10, 2011-11, 2012-05, 2013a, 2013b)

Table 3

Percentage of ACTs starting in 4-year (2-yr) colleges who are:			
Proficient in Math and interested in STEM	A 24% (8%)	B 35% (17%)	Proficient in Math but not interested in STEM
Interested in STEM but not Proficient in Math	C 11% (17%)	D 30% (58%)	Not interested in STEM and not proficient in Math
ACT & Business Higher-Ed Forum. www.ncci-cu.org/downloads/BHEF_STEM.pdf			
www.bhef.com/sites/g/files/g829556/f/brief_2012_stem_interest_enrollment.pdf			
C and D are reversed in BHEF May 2012. "Math proficient" if ACT Math is at least 22 (60th percentile)			

Now consider the left half of Table 3: those interested in STEM. At four year colleges, *31% of those interested in STEM are NOT math proficient (11/35)*: At two-year colleges, most (68%) of those interested in STEM are NOT math proficient. The lack of proficient math skills among those interested in STEM might explain much of the high dropout rate.

Now consider the top half of Table 3: those proficient in math. *Most of those proficient in math are not interested in STEM*: 55% at four-year colleges (35/59); 68% at two-year colleges (17/25).

This proposal focuses on those in the upper half who do not start as STEM majors. Knowing that women are a minority among those who graduate with STEM majors and assuming that men and women are equally split among those who are proficient in math implies that women are likely to be a majority among those who are proficient in math but not interested in STEM.

The goal of this proposal is to increase the number of STEM graduates by providing a new doorway that may be more attractive to those who are – or want to be – verbally fluent. Ceci and Williams (2010) found that the correlation between verbal and math is higher among women than among men. Among those who are math proficient, this difference gives women more choices than men. By designing a Science-Skills doorway that will attract those who are verbally fluent, this should attract more women and then convert some of these to STEM majors.

Our focus on improving verbal skills – as a means of improving math skills – is also of special interest to students for whom English is a second language – and even for native English speakers who are less fluent. This approach is based on the experience of Orr (1987) who found that a lack of grammatical fluency (c.f., prepositions, comparatives and relative clauses) was responsible for deficits in reasoning and in calculation. Here is one example: 40 divided by 5 is the same as 5 divided into 40, but different from 5 divided by 40. If a student can't distinguish 'by' from 'into', 'to' and 'from', 'start' from 'finish' then they will have problem distinguishing 'premise' from 'conclusion', 'half more' from 'half of', or 'the percentage of women who are runners' from 'the percentage of runners who are women'. Is eight 'four times more than two' or 'four times as much as two'? Is 'two' four times less than 'eight'?

The W. M. Keck Statistical Literacy project funded extensive research on the use of ordinary English to describe and compare ratios using percent, percentage, rate and chance grammars. See Schield (2000, 2001 and 2011). It also generated an online program that tutors students on using ordinary English in describing and comparing rates and percentages as presented in tables, graphs and statements. Non-native speakers find this drill program extremely helpful.

By focusing on math-proficient students in non-STEM majors (c.f., women and ESL), the over-arching goals of increasing STEM graduates and impacting 100,000 students can be achieved.

Institutional Readiness.

Augsburg College, founded in 1869, is a private college set in a vibrant neighborhood at the heart of the Twin Cities. Augsburg offers more than 50 undergraduate majors and seven graduate degrees approximately 3,700 students of diverse backgrounds. The trademark of an Augsburg education is its emphasis on direct, personal experience. Guided by the faith and values of the Lutheran church, Augsburg educates students to be informed citizens, thoughtful stewards, critical thinkers, and responsible leaders.

Augsburg's undergraduate program of liberal arts and sciences is offered on both a traditional weekday schedule and a non-traditional weekend and evening schedule. The Core Curriculum combines liberal arts, major coursework, and Augsburg's signature courses to prepare students to be leaders and stewards of our ever-changing world. Students in all of our programs learn outside of the classroom through service learning, internships, fieldwork, consulting projects, and study abroad. It's this commitment to hands-on learning, combined with the opportunities our city offers, that makes Augsburg's educational experience unique.

Augsburg students come from 43 states and 26 countries to live and learn. In 2012, 29% were students of color. In the day college, 29.4% were first generation students, 42.7% were Pell eligible, and 6.5% were TRiO/Student Support Services Program participants.

The next table presents the demographic distribution of the major racial and ethnic groups along with percentage totals for under-represented minorities and for women. Augsburg aligns with national data showing that women are under-represented in Engineering and Computer Science.

Table 4

Augsburg College: Fall 2013. Population: Undergraduate Day students with Major1 in STEM

Major1	???	Asian	Black	Hispanic	Am.Ind	Mixed	White	Total	URMinor	Female
Biology	9.4%	5.6%	18.8%	5.0%	0.6%	3.8%	56.9%	160	28%	58%
Chemistry	6.9%	13.8%	13.8%	8.6%	1.7%	6.9%	48.3%	58	31%	55%
Computer Sc	11.3%	15.5%	11.3%	4.2%	1.4%	2.8%	53.5%	71	20%	11%
Engineering	8.6%	14.3%	5.7%	14.3%	0.0%	17.1%	40.0%	35	37%	6%
Mathematics	2.9%	8.6%	2.9%	2.9%	0.0%	5.7%	77.1%	35	11%	40%
Physics	6.7%	3.3%	13.3%	10.0%	0.0%	3.3%	63.3%	30	27%	30%
STEM Total	8.5%	9.5%	13.6%	6.4%	0.8%	5.4%	55.8%	389	26%	40%
Augsburg UGD	12.2%	8.2%	10.1%	6.3%	0.9%	4.8%	57.1%	1926	22%	50%

Existing Augsburg Programs:

Augsburg STEM programs are designed to support undergraduate students who are pursuing careers in STEM. This can encompass a number of majors including physics, chemistry, biology, computer science, biopsychology, and mathematics. To maintain and enhance Augsburg's vital STEM community, this office provides students with opportunities to conduct research with faculty, attend and present at national conferences, and hear from leading researchers in these fields.

The AugSTEM program is designed to support Augsburg juniors and seniors who wish to pursue a career in science, technology, engineering, and mathematics. Funded by the National Science Foundation, AugSTEM Scholars can receive up to $7,000 per year in financial support. Scholars

also become a part of the STEM community at Augsburg with opportunities for summer research, faculty mentoring, and career development.

Additional opportunities available in STEM include The McNair Scholars Program, which aims is to increase graduate degree awards for students from underrepresented students, and the Undergraduate Research and Graduate Opportunity (URGO) Program, which provides students with research and internship opportunities.

Augsburg College is supportive of this proposal. Academic Affairs approved Statistical Literacy as a catalog course in 1997. Institutional support includes a commitment to offering two of the courses in the proposed Science-Skills minor, GST 200 and PHI365, at least once a year in the Day program, with the first offered by Spring 2015. Additional support is available from Dr. Rebekah Dupont, Director of STEM Programs, who will attend the annual STEM Institute and STEM Conference.

The project team includes the Principal Investigator, Dr. Milo Schield (Management Information Systems), the co-Principle-Investigator, Dr. Larry Crockett (Computer Science), Professor Marc Isaacson (MIS), the Director of Sponsored Programs, Erica Swift (Institutional Advancement), and the Dean of Arts and Sciences, Dr. Amy Gort. The project team has already been in discussion regarding course content revisions and deployment of the Science-Skills minor.

Implementation Plan.

This project will establish a new doorway to STEM that is consistent with the AAC&U learning outcomes deemed 'essential for knowledge and skill development.' The courses start with gentler steps of greater interest than traditional mathematics, but are still math focused.

Students are curious about people and are quite interested in social, health and job issues; these typically involve statistics. Students in group B of Table 3 often find symbolic mathematics de-motivating. By embodying algebra inside Excel, by including STEM inside real-world social-economic data, and by focusing on statistical literacy as quantitative rhetoric, students who say they are not interested in statistics or STEM are much more likely to change their mind. Wired magazine named statistical literacy as the #1 course student should have taken at college. Data analytics and "big data" are new and "hot" with students.

This proposal envisions a new "Science-Skills" minor: a six course minor that involves no new courses – although two will need to be enhanced.

(1) Problem Solving with Excel: logic functions, graphs, pivot tables, modeling, macros/VBA, or an entry-level computer-science course.

(2) Statistical literacy or traditional statistics with 15% Statistical Literacy content: Excel-based. Schield (2006) shows how context can influence statistical associations.

(3) Philosophy of Science with attention to both experimental and observational studies. Primary focus on why Science should be viewed as a liberal art. See Schield's (2005). PKAL paper.

(4) An observational science course such as epidemiology, astronomy or data analytics.

(5) An experimental science course such as entry physics, chemistry or biology.

(6) A liberal arts skills course such as critical thinking, persuasive argumentation, science writing or logic

These courses were selected using two criteria. For Liberal Arts majors, what courses would help them the most in understanding how science generates knowledge. For Science majors,

what six courses would help them the most in reflecting on the knowledge claims they are making, and in communicating the results of their efforts to others. Presumably liberal arts majors will have taken – or are generally interested in taking – courses in communications, English and Philosophy. Science majors will have taken – or are generally interested in taking – courses in the sciences or on the philosophy of Science. For both groups, this Science-Skills minor will act as extension of a good general education program.

Implementing the Minor: The following outlines some of the steps in transforming the idea of a Science Skills minor into an academic reality. These steps are classified into internal and external depending on whether they affect Augsburg students or students at other institutions.

- Internally, there are four steps: (1) Submit the new minor to Academic Affairs for their approval. Since it doesn't involve any new courses, that should not be a problem. (2) Poll Augsburg students on their interest in this new Science-Skills minor. (3) Advertise the program to Augsburg students. Students that designate this minor and submit a written or video reflection on their experience with each course will receive a modest stipend. (4) Tabulate and evaluate the results of student feedback. Do they have a stronger interest in STEM courses, minor or major than they did before they started?
- Externally there are two distinct activities. One involving just the teaching of statistical literacy; the second involved in promoting this Science-Skills minor as a new doorway to STEM for non-STEM minors and a new doorway to the liberal arts for STEM majors.
    1. The teaching of statistical literacy requires faculty training: helping other faculty teach statistics as a literacy course instead of as a math course. A faculty training program has been designed and tested on faculty from Keene State College. Based on their feedback, the training program has been improved. (1) Update faculty training materials. (2) Have these updated materials reviewed by previously trained faculty. (3) Advertise the online faculty training program along with the stipend for those that complete the training and submit a written or video reflection on their experience. (4) Offer the online training program in 2014-15. (5) Organize a summer conference at Augsburg that presents these faculty reflections and provides on-site training for future faculty. Steps 3, 4 and 5 will be repeated each year. The only difference is that the stipends for reviewers and beta testers will get smaller as the program becomes better established.
    2. Promoting this Science-Skills minor as a new doorway between the Liberal Arts and STEM will involve a number of activities. (1) Presentation of papers at conferences and/or publication of papers in journals sponsored or owned by the AAC&U, PKAL or similar organizations. (2) Preparing web videos that promote interest in this new minor. (3) Hosting these materials on a web site that has an existing faculty audience. (4) Monitoring adoptions by other colleges and universities.

Internally, the final step will be to assess all of these activities for their impact on students and report the results to the project team and to the AAC&U/PKAL.

Members of the project team will participate in the annual STEM Institute and annual STEM Conference.

Activating the Minor: The implementation of this minor involves a different set of activities from the students' perspective.

- In taking the Excel course they will not only learn a new tool, but they will work unstructured problems that have multiple "right" answers. They will learn how to make tables, graphs and models so they can communicate the results to others. This course satisfies part of Augsburg Quantitative Literacy requirement. This is an inter-disciplinary tool they can use in the personal and professional lives. They will be introduced to computer programming. First with keystroke recorder macros and then with Visual Basic programming. Knowing the rudiments of Visual Basic can qualify them for better jobs and provide a doorway to Computer Science programming. This course is being taught at Augsburg by Professor Marc Isaacson.
- In taking statistics students will be studying one way the scientific method is implemented when dealing with subjects or measurements that are unique or highly variable. In taking statistical literacy, students will participate in numerous activities.
    - They will analyze the use of statistics in ten to 25 news stories using a new online forum (Odyssey) in which everyone is anonymous, everyone grades everyone else and the computer tabulates power for each player. This is the primary writing component of this course (Schield, 2014).
    - They will work hundreds of right-wrong exercises with immediate feedback using Moodle to develop the quantitative reasoning skills.
    - They will use the online grammar-checker to improve their use of ordinary English in describing and comparing rates and percents in graphs, tables, surveys and articles.
    - They will participate in individual or group activities that illustrate statistical ideas.
    - They will use Excel to summarize and model data using skills from the Excel course.
    - This course is taught at Augsburg by Dr. Milo Schield and Professor Marc Isaacson.
- In studying the Philosophy of Science they will discuss how Science creates knowledge that is robust and resilient in the face of new discoveries. They will learn the difference between hard science (laboratory repeatable manipulation) and soft science (purely observational or model-based simulation). They will see why some scientific findings are easily overturned whereas others are not. This overview of the scientific method may inspire them to learn more about a particular science or to choose a STEM major. This course will be taught at Augsburg by the co-PI, Dr. Larry Crockett.

Our goal is to give students a positive experience in dealing with numbers (statistical literacy) and in dealing with some of the big issues in science. In high school, students say they are interested in science and math, but not in the science and math courses they are taking. Osborne (2003). In college, students taking research statistics report seeing less value in statistics after completing the course than they did before they start. STEM definitely needs new doorways to attract and retain more majors.

Students in non-quantitative majors who take statistical literacy agree that this course should be a required course for all college students. Schield (2008). This is a practical skills course that helps them make sense out of numbers whether in the news, in personal decisions or in their professional lives.

Field-Testing: Augsburg can't compete with the Carnegie foundation, but with its strong emphasis on under-represented groups (34% students of color, 51% women), Augsburg can field test this new approach before dissemination. Augsburg College has offered Statistical Literacy

for over 10 years to over a thousand students, piloted an Excel-based Statistical Literacy course and is developing a follow-on course in Excel-based data analytics. Having obtained a $500,000 grant from the W. M. Keck Foundation in 2001 to develop Statistical Literacy, Augsburg is prepared for rapid and effective dissemination.

Sustainability: By using existing catalog courses, Augsburg does not need any special funding to maintain this program after the grant ends. Online faculty training in statistical literacy is expected to continue in future years by charging new faculty a small amount for their training. For more details see Dissemination.

Management Plan

The project will be managed by the Principal Investigator, Dr. Milo Schield. Dr. Schield is an elected member of the International Statistical Institute (ISI) with over 60 papers on statistical literacy. He is the US coordinator of the International Statistical Literacy Project. See www.StatLit.org/Schield.htm Dr. Larry Crockett, co-PI, has authored several books and papers on computing and philosophy of science. He has been in charge of the Augsburg Honor's program for many years. Professor Marc Isaacson (BA. Economics; MS, Engineering) teaches the Augsburg Freshman Seminar and has authored several papers on Statistical Literacy. He participated in the NSF/DUE-funded "Spreadsheets across the Curriculum."

The project team will work under the authority of the Dean in charge of the Arts and Sciences, who will provide assistance and approval for curricular revisions and implementation of the minor. The Director of Sponsored Programs and Administrative Accounting will support the administration and financial management of the project, and ensure the disbursement of funds is properly controlled.

The project team will meet regularly to discuss progress and identify areas for continued improvement. As such, there may be changes to the project plan to improve our success at reaching our objectives. Any changes to the project plan– and the associated allocation of funds, will obtain pre-approval of all parties. Annual reports will be submitted by the Principal Investigator for review and approval by the administration before their submission to PKAL.

Institutional Impact:

Liberal arts majors have increasing concerns about getting good jobs. The news science-skills minor will provide them with workforce-ready tools that may help them get better jobs. A study of jobs on Career Builder showed that Excel was mentioned four times as often as SQL and 20 times as often as C++.

JOBS BY LANGUAGE, O/S or DATABASE QUERY
CAREER BUILDER: JOBS POSTED IN LAST 30 DAYS

LANGUAGE	ALL	MN	MSP
Windows	20,121	455	128
SQL	16,357	414	130
Oracle	9,455	246	87
Java	8,244	127	48
Linux	5,951	111	**
Visual Basic	3,416	74	**
C++	2,762	38	**

JOBS BY COMPUTER APPLICATION
CAREER BUILDER: JOBS POSTED IN LAST 30 DAYS

APPLICATION	ALL	MN	MSP
Excel	71,536	1,721	511
Access	52,765	1,205	359
PowerPoint	19,392	490	157

Additionally, Augsburg's campaign to build its Center for Science, Business, and Religion, with an anticipated construction start date within the next year, means it has committed itself to a

degree of disciplinary integration that is rare in the contemporary collegiate environment. Programmatically, the Center means the college will implement a number of minors to facilitate the integration, one of which will be this new minor. Key to this endeavor will be a substantial improvement in both appreciation for and understanding of science across the curriculum. Not only does this mean greater understanding of science and its implications for business practice, for example, it means a more sophisticated understanding of both the potential and the limitations of science. This entails a philosophical assessment of science so that our students do not leave with a naive understanding of science born more of the media than the practice of science. Consequently, the science skills emphasis of the proposal will dovetail in a remarkable way with our new Center and our renewed commitment to an interdisciplinary understanding of science that informs all the disciplines.

Dissemination:

The success of this proposal is strongly dependent on faculty training and academic advertising. Faculty training will be done using web-training materials. The project director, Milo Schield, maintains the world's largest website dedicated exclusively to statistical literacy – with close to 200,000 visits per year. Advertisements for this project will be feature on this website as a separate page.

A significant portion of the grant is dedicated to marketing: developing faculty training materials, disseminating this new approach, and encouraging other colleges to adopt this curriculum The three-year goal is to reach and train over a 100 statistical educators and have at least five schools agreeing to implement this minor. The ten-year goal is 70 schools impacting at least 2,000 students. Conversations have been initiated with colleagues at six other schools on this new Science-Skills minor.

Evaluation Plan

The objective part of evaluation plan is simple. (1) Did 20 Augsburg students sign up for this new Science-Skill minor? (2) Were at least 100 faculty trained in teaching statistical literacy? (2) Did at least 5 other schools adopt the PKAL Science-Skills minor by year three? (3) Did those schools impact at least 10 students per school year? (4) How many of those students took additional STEM courses, elect a minor in STEM, a STEM major or a major in Computer/Information Science? Additionally, we will evaluate how students' opinions changed during the course of the minor. Did they see value or utility in the courses they took? All data will be collected, analyzed by the project team in conjunction with the external evaluator. Results will be disseminated at academic conferences, manuscripts, and through the statistical literacy website.

Our external reviewer will evaluate yearly progress and submit a final summative report on the entire project.

Conclusion

The PKAL call for proposal mentioned three goals: (1) increase participation of underrepresented groups in STEM courses/majors, (2) "development of a multi-disciplinary introductory STEM curriculum" and (3) impact 100,000 students.

Embedding Excel training, critical thinking about statistics (statistical literacy) and the cultural value of scientific knowledge (philosophy of science) into a multi-disciplinary STEM-based

curriculum is a unique approach to fostering scientific literacy. Enhancing scientific literacy is a new doorway for attracting under-represented mathematically-proficient students (mainly women) into STEM courses/majors. With rapid dissemination, this project can assist PKAL in impacting 100,000 students on becoming STEM majors.

Benefit to Students: By focusing on job skills (Excel) and student appreciation (Statistical and scientific literacy) this minor may set a new direction for science education. With this softer approach, they may find STEM courses more interesting, useful and valuable.

Benefit to PKAL: By supporting this proposal, the AAC&U can demonstrate how the humanities can connect with the sciences and bridge C. P. Snow's "two cultures," increase the prevalence of under-represented groups in STEM, and influence thousands of students to take STEM courses they find interesting, useful and valuable.

BIBLIOGRAPHY:

Business Higher-Education Forum (2006). Research Brief. The Challenge of the New Demographics of Higher Education: Increasing Women and Minority Participation in the STEM Disciplines. www.bhef.com/sites/g/files/g829556/f/brief_2006_new_demographics.pdf

Business Higher-Education Forum (2010). Report: Increasing the Number of STEM Graduates: Insights from the U.S. STEM Education & Modeling Project. Downloadable from www.bhef.com/sites/g/files/g829556/f/report_2010_increasing_the_number_of_stem_grads.pdf

Business Higher-Education Forum (2011-08). Research Brief – August. Creating the Workforce of the Future: The STEM Interest and Proficiency Challenge. Downloadable copy at www.bhef.com/publications/creating-workforce-future-stem-interest-and-proficiency-challenge

Business Higher-Education Forum (2011-10). Research Brief – October. Meeting the STEM Workforce Demand: Accelerating Math Learning Among Students Interested in STEM. Copy at www.bhef.com/sites/g/files/g829556/f/brief_2011_accelerating_math.pdf

Business Higher-Education Forum (2011-11). Research Brief – November. Leveraging Higher Education's Untapped Potential To Prepare Tomorrow's STEM Workforce. http://www.bhef.com/sites/g/files/g829556/f/brief_2011_untapped_potential.pdf

Business Higher-Education Forum (2012-05). Research Brief – May. STEM Interest Among College Students: Where They Enroll. Downloadable copy at www.bhef.com/sites/g/files/g829556/f/brief_2012_stem_interest_enrollment.pdf

Business Higher-Education Forum (2013a). Report: Literature Review: Highly Effective Undergraduate Intervention Strategies. Downloadable copy at www.bhef.com/sites/g/files/g829556/f/201305/report_2013_FinalInterventionsResearch.pdf

Business Higher-Education Forum (2013b). The U.S. STEM Undergraduate Model: Applying System Dynamics to Help Meet President Obama's Goals for One Million STEM Graduates and the U.S. Navy's Civilian STEM Workforce Needs. www.bhef.com/publications/us-stem-undergraduate-model-applying-system-dynamics-help-meet-president-obamas-goals

Carnevale, Anthony, Nicole Smith and Michelle Melton (2011). STEM. Georgetown University. Center on Education and the Workforce.

Ceci, Stephen and Wendy Williams (2010). Sex Differences in Math-Intensive Fields. *Current Directions in Psychological Science* October 2010 vol. 19 no. 5 275-279 http://cdp.sagepub.com/content/19/5/275.short

Osborn, Jonathan, Shirley Simon and Sue Collins (2003).Attitudes towards science: a review of the literature and its implications. *International Journal of Science Education* 2003, Vol. 25, No. 9, 1049–1079. ISSN 0950–0963 print / ISSN 1464–5289 online. Taylor & Francis Ltd

Orr, Eleanor Wilson (1987), *Twice as Less: Does Black English stand between black students and success in math and science*. New York: W. W. Norton & Company.

Schield, Milo (2000). Statistical Literacy: Describing and Comparing Rates and Percentages. *2000 American Statistical Association Proceedings of Section on Statistical Education*, pp. 76-81. See www.StatLit.org/pdf/2000SchieldASA.pdf.

Schield, Milo (2001). Statistical Literacy: Reading Tables of Rates and Percentages, *2001 American Statistical Association Proceedings of Section on Statistical Education*, [No pages numbers given]. See www.StatLit.org/pdf/2001SchieldASA.pdf.

Schield, Milo (2004). Statistical Literacy and Liberal Education at Augsburg College. *Peer Review*, Sept. 2004, 7-14. American Association of Colleges and Universities (AAC&U). See www.StatLit.org/pdf/2004SchieldAACU.pdf.

Schield, Milo (2005). Making Science a Core Liberal Art for the 21st Century. Project Kaleidoscope. See www.StatLit.org/pdf/2005SchieldPKAL.pdf.

Schield, Milo (2006). Presenting Confounding and Standardization Graphically. *STATS Magazine*, American Statistical Association. Fall 2006. pp. 14-18. Copy at www.StatLit.org/pdf/2006SchieldSTATS.pdf.

Schield, Milo (2008). Quantitative Literacy and School Mathematics: Percentages and Fractions, in *Calculation vs. Context: Quantitative Literacy And Its Implications for Teacher Education*. Edited by Bernard L. Madison and Lynn Arthur Steen. 2008 Mathematical Association of America. P. 87-107. See www.statlit.org/pdf/2008SchieldMAA.pdf

Schield, Milo (2011) Describing Arithmetic Relations Using Informal Grammar. *2011 American Statistical Association Proceedings of the Section on Statistical Education*. [CD-ROM] P. 911-925. See www.StatLit.org/pdf/2011SchieldASA.pdf

Schield, Milo (2014). Odyssey: A Journey to Lifelong Statistical Literacy. ICOTS-9. Flagstaff, AZ. See www.StatLit.org/pdf/2014-Schield-ICOTS.pdf