PROJECT SUMMARY

Overview:

Pre-Alliance Planning for
The Coalition for Promotion of Underrepresented Minorities in Academic STEM
(PUMA-STEM)
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Christopher N. Anderson, Co-PI, Dominican University
Victor Govindaswamy, Co-PI, Concordia University Chicago
Matthew Kirkpatrick, Co-PI, Oak Park River Forest High School
Eve M. Mellgren, Co-PI, Elmhurst College
Amy Paulus, Co-PI, Proviso Math and Science Academy
Charles A. Zona, Co-PI, Hooke College of Applied Sciences and The McCrone Group, Inc.
The higher education landscape is changing, with broadened participation by ethnic groups traditionally largely excluded from obtaining an undergraduate degree. At the forefront of these changing demographics are, surprisingly, not larger universities, but rather small local universities and community colleges. Yet, the barriers to successfully matriculating into and obtaining STEM-related undergraduate degrees are often difficult to overcome for underrepresented minorities even within a smaller university system. Financial concerns, outdated pedagogies, and cultural/traditional unfamiliarity with higher education (e.g., among first generation students) can all be impediments to a positive college transition that would lead to successful employment in a STEM-related career. Although STEM programming has rapidly expanded over the past decade, there is very little cohesiveness or structure among programs serving underrepresented minorities. The academic coalition model presents the opportunity to create a comprehensive strategic plan among academic and business entities to reduce obstacles that impede the growth of underrepresented minorities in STEM-related careers.

Intellectual Merit :

A long-term LSAMP alliance among local high schools, small colleges and universities will lead to cooperation that will facilitate the development of effective pedagogical approaches to increase underrepresented minority participation in STEM academics and careers. The planning process will allow the Coalition to develop an infrastructure based on best practices and research and to coordinate effective and efficient solutions to reduce barriers for minorities in STEM-related fields. This program will provide students new intellectual opportunities, engagement in high-impact practices, and advancement support to complete high school and STEM undergraduate degrees. The result will be a strong academic support network and coordinated programming strategy for extended outreach beginning at the high school level.

Broader Impacts :

The expected outcome of the planning process will be strong established, coordinated partnerships from high school to university to employment in STEM. The coalition model, with a multi-tiered approach including implementation of best practice pedagogy, social and/or financial supports, will result in increased enrollment and graduation from STEM majors as well as a diversification of the STEM workforce. The coalition structure also provides for future expansion of the high school-college-industry network to improve outreach and strengthen the overall academic foundation for underrepresented minorities in STEM programs.

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Project Description
Background and Context

Barriers to STEM

An increase in college enrollment among underrepresented minorities is occurring primarily in smaller, local universities and community colleges (Carnevale & Strohl, 2013; Swail, 2003). Still, significant variation exists across ethnicities in the proportion of the each sub-population that obtain bachelor degrees (National Science Foundation [NSF], 2013). A 2012 survey of 22- to 24-year-old U.S. citizens showed that 38% of Asians and 22% of Whites had completed at least a bachelor's degree; however, this could only be said for 12% of Blacks and 11% of Hispanics (Fry & Taylor, 2013). Barriers to successfully matriculating into and graduating from STEM undergraduate programs even within a smaller university system are often difficult to overcome for underrepresented minorities (Packard, 2011; Swail, 2003). Many entrants into academic STEM exit their programs by changing majors or leaving college without completing a degree or certificate. Studies have frequently found that underrepresented minorities, first-generation students, and those from low-income backgrounds leave STEM fields at higher rates than their counterparts (Anderson & Kim 2006; Griffith 2010; Huang, Taddese & Walter 2000; Shaw & Barbuti 2010), even when controlling for factors such as financial aid, loans, gifts, and work-study programs (Whalen & Shelley, 2005). STEM attrition also occurs more frequently among students with weaker academic backgrounds (Astin & Astin 1992; Mendez, Buskirk, Lohr & Haag, 2008; Shaw & Barbuti 2010; Whalen & Shelley 2010).

Robust high school STEM curricula, including advanced mathematics, greatly increase the chances that low-income and first-generation students will attend college, particularly four-year institutions (Choy, 2001; Horn & Nunez, 2000); however, sending first generation students, many of whom are from minority groups, into advanced coursework without adequate support is a set up to failure (Engle & Tinto, 2008). Strengthening efforts to support underrepresented minorities with well-defined pathways from high school to STEM programs and careers will have significant individual and societal benefit. There exists an unmet need for a STEM-capable workforce and the economic future of the nation depends on preparing more students to enter these fields (National Research Council [NRC], 2011; Holdren & Lander, 2012).

Although there is a wealth of STEM programming nationwide, there is very little cohesiveness or structure among most programs serving underrepresented groups in STEM (Lyon, 2013). Furthermore, there are few confluent programs that support students from high school into and through four-year degrees in STEM (Lyon, 2013; Sneider, 2011). U.S. born African-American, Hispanic, and American Indian students continue to be severely underrepresented within STEM graduate programs (Humes, Jones & Ramirez, 2010; NSF, 2011a). Financial concerns, lack of specific educational training at the high school level, or even cultural/traditional unfamiliarity with higher education (e.g., among first generation students) can all be impediments to a positive college transition that would lead to successful employment in a STEM-related career (Clewell, de Cohen, Tsui, Forcier, Gao, Yung, Deterding & West, 2005; Swail, 2003).

Various factors have been shown to impact participation in STEM classes and majors at high school and college levels (Palmer & Wood, 2013; Engberg & Wolniak, 2013; Wang, 2013).

Examples include underservice of Hispanic and African-American students and a lack of effective pedagogies to insure college readiness of underrepresented minorities (Palmer & Wood, 2013). Student attitudes and dispositions about STEM, as well as postsecondary experiences, have also been demonstrated to play an important role (Engberg & Wolniak, 2013). Specifically, postsecondary selectivity at the college level has been shown to have a negative effect, as does the lack of sufficient collaborations among high schools and colleges (e.g., dual-enrollment programs) to improve participation and performance of underrepresented minorities in STEM (Engberg & Wolniak, 2013; Mitchell, 2015). Further approaches shown to be important for increased minority participation in STEM include increased high school exposure to math and science courses, academic integration at the college level, and receipt of financial aid (Wang, 2013).

Recent progress in promoting the participation of underrepresented minorities in STEM
Despite long standing national efforts to increase participation from minorities underrepresented in STEM academic programs and careers, the proportion of underrepresented minorities (African-Americans, Hispanics, and indigenous Americans) with STEM degrees/certificates has not improved markedly since 2001 (Chen, 2013). In 2001, computing degrees comprised 31% and engineering degrees comprised 32% of all undergraduate degrees obtained by these minority groups; in 2013, these percentages had only increased to 35% for both fields (Chen, 2013). Such slow progress indicates that previous measures to improve the performance of minorities in STEM fields have been inadequate. Identifying and addressing the reasons for this slow progress will drive the planning activities of the proposed Coalition.

More robust improvements have been observed at earlier educational checkpoints in subjects such as math, but there is significant state-by-state variation in the magnitude of success. For example, between 2003 and 2013, 8th grade Black and Hispanic students in Illinois showed moderate gains in their performance on National Assessment of Educational Progress (NAEP) math section (U.S. Department of Education, 2003-2013). Black Illinois students increased their average scores of 249 to 260. Similarly, Hispanic Illinois students increased their average math scores from 259 to 272 (U.S. Department of Education, 2003-2013). However, more work needs to be done locally, as these same ethnic groups in Massachusetts and New Jersey had nearly double this improvement in math scores: +20 points in ten years (U.S. Department of Education, 2003-2013). Understanding the factors that drove the observed improvement in Massachusetts and New Jersey may be important to developing best-practice approaches to increase success of underrepresented minorities in Illinois (and other states lacking such marked improvement) on the NAEP test. The primary objective of this proposed LSAMP alliance, *The Coalition for Promoting Underrepresented Minorities in Academic STEM* (PUMA-STEM), will be to improve the participation and success of STEM students from underrepresented minority groups in Illinois communities west of Chicago.

Developing secondary and postsecondary cooperation for best practice STEM education
Underrepresented minorities in STEM frequently choose colleges/universities geographically proximal to the high school they attend (Carnevale & Strohl, 2013). Thus, bolstering collaboration and cooperation among secondary and postsecondary institutions in local regions

has significant potential to benefit and support underrepresented minorities in a cohesive, multi-stage manner for individual cohorts.

Discussing and sharing strategies to bring best practice STEM education into high school and college classrooms is a central aim of the pre-alliance planning activities. Active learning (Bonwell & Eison, 1991) interventions improve achievement for all students; those with disadvantaged and ethnic-minority backgrounds gain the most (Stark & Freishtat, 2014). In addition to planning and discussing how the Coalition can use active learning and inquiry-based education techniques in class (Hutchings, 2006; Wadman, deProphetis Driscoll & Kurzawa, 2009), additional discussions of how to bridge the gap between STEM core content and out-of-school programs at the secondary level are warranted (Tran, 2011; Fallik, Rosenfeld & Eylon, 2013; Nasir & McKinney de Royston, 2013).

Educator support and the creation of diverse, inter-institutional pathways to STEM

One obstacle to the recruitment of high schoolers to STEM-related majors is the level of exposure to STEM-related curriculum at the high school level. Many K-12 teachers in the U.S. lack a strong background in math and science. Remarkably, recent data show that only 48% of 8th graders in the United States have science teachers with an undergraduate degree in science (U.S. Department of Education, 2011). 36% of public middle school math teachers in 2007 either did not major in the subject in college and/or are not certified to teach it (NSF, 2011b). Yet, it is during these formative years that all students need trained scientific mentors, curriculum experience and encouragement to pursue STEM. Workshops and planning activities to facilitate training among high-school and college faculty, as well as increased mentorship opportunities for underrepresented minorities in STEM, represent important steps to improve their participation and success in STEM.

Few programs have been developed to strengthen pathways for underrepresented minorities into STEM programs and careers cooperatively among high schools, colleges/universities, and STEM businesses (Lyon, 2013; Clewell, et al., 2005). However, it is the establishment of such a network that will facilitate partnerships to help students move from one stage to the next (e.g., from high school to academic STEM program and from collegiate STEM to graduate programs or STEM workforce).

A 2009 U.S. Bureau of Labor Statistics projection found that 16 of the 20 occupations with the largest expected growth are STEM related; however, only 4 of them require an advanced degree (Lacey & Wright, 2009). Moreover, since the 1970s, the number of jobs that require at least "some college" has dramatically increased, whereas opportunities for individuals with just a high school education have shrunk dramatically (Symonds, Schwartz & Ferguson, 2011). Hence, it is important to establish multiple pathways for underrepresented minorities from high school through collegiate STEM programs and into STEM careers.

Revealing the economic prospects of individuals in STEM careers constitutes a potentially important activity to incentivize and promote interest in STEM among underrepresented minorities. A survey of 32,000 online job sites found that, in 2013, there were 5.7 million total postings in STEM fields and 76% of them required at least a bachelor's degree (Burning Glass Technologies, 2014). The same study indicated that entry-level STEM jobs requiring a BA or higher offer a 26% salary premium (average advertised salary of $66,123)

compared to $52,299 for non-STEM jobs, further illustrating the importance of increasing diversity in STEM to promote a more economically balanced society.

Potential for early wins through high school-to-college networks

Nationwide, 39% of public school students from the class of 2014 who had the potential to succeed in an AP class did not take one (College Board, 2014). In Illinois, 45% of minority students with the potential to succeed on a STEM AP test never took the STEM AP test (College Board, 2014), suggesting that collaborative efforts among high schools, colleges and universities to increase this percentage may be an early win with respect to increasing participation of these students in STEM programs at the college level. Planning activities proposed herein will broaden possibilities for dual credit coursework at the high school level and investigate high-impact activities, e.g., inquiry-based learning, active learning, and student-centered learning (Friedlaender, D., Burns, D., Lewis-Charp, H., Cook-Harvey, C.M., & Darling-Hammond, L., 2014), with substantial and quantifiable benefits to underrepresented minorities in STEM.

Online learning represents another important avenue for increased participation of underrepresented minorities in STEM. Using data from more than 2,000 community college STEM majors, it was demonstrated that even after controlling for other factors, Blacks and Hispanics were significantly underrepresented in online courses (Wladis, Hachey & Conway, 2015). Although online course offerings are unlikely to attract new students, they can help existing students attain a degree in STEM (Jaggars & Xu, 2010). Planning activities that increase participation and success of underrepresented minorities in online STEM coursework should be beneficial in this regard.

Need for improved mentorship and culturally familiar role models

A key focus for the Coalition for PUMA-STEM will be development of programs to provide students from underrepresented minority groups more professional role models and mentors in STEM. The majority of college students who decide to pursue a concentration in STEM appear to make that choice during high school (Maltese & Tai, 2011). Research suggests that this choice is more related to a growing interest in mathematics and science rather than mere academic proficiency (Maltese & Tai, 2011). Thus, focusing only on increased student participation in advanced-level courses and achievement as measures to increase the flow of students into STEM may be misguided (Maltese & Tai, 2011). Exposure of students to the work of scientists and engineers can help them graduate from academic programs in STEM (D'Souza, Kroen, Stephens & Kashmar, 2012). In addition, there is a significant need for effective faculty and peer-mentors (D'Souza, et al., 2012) in retaining minorities in STEM programs and promoting their success. Planning of this proposal will emphasize a research-based model of employing best practices in STEM education (Bradford, Miller, Dichtel, Leibovich, Feig, Martin, Bjorkman, Schultz, & Smith, 2015) in the demonstrated context that all individuals learn and interact with their surroundings based on their culture (Ibarra, 1999; Hall, 1981). Emphases will be on the value of diversity, strong mentorship, relevant cultural context, and student engagement in professional development activities (Brown, 2011). Out-of-school science camps, microscopy outreach, and other STEM mentorship programs are already being employed at individual institutions in the PUMA-STEM Coalition; however, the funding provided through this grant would facilitate

exploration of additional opportunities for increased collaboration, coordination, and expansion of programs for students from ethnic minority groups underrepresented in STEM.

Creating opportunities for students to work with faculty and peer mentors, and other role models in STEM, is an essential component of this planning proposal. PUMA-STEM will leverage cooperation and synergy among its partners to transfer/expand already beneficial programs in use at individual sites more broadly among partnering institutions. The Coalition will also operate to create stronger infrastructure of pathways involving mentorship and other aspects of student support for underrepresented minorities in STEM. Finding practical and effective approaches to improve recruitment and success of these students in collegiate STEM programs has the potential to drive numerous positive intellectual and socioeconomic sequelae. PUMA-STEM will strive to provide clearer pathways for underrepresented minorities to enroll and succeed in STEM-related programs at four-year schools and develop opportunities for enrollment in STEM graduate programs and/or careers in STEM.

Given the success of the LSAMP model and the fact that LSAMP projects often foster student connections both within their institution *and* connections outside of the institution (Clewell, et al., 2005), the proposed PUMA-STEM Coalition will expand the outreach by coordinating and aligning programming and strategies at multiple academic levels. Recently, the Committee on Institutional Cooperation, a committee of 15 large, research-based universities was formed to analyze STEM teaching and impact and share results on a common set of student success measures (Bradford, et al., 2015). The present proposal seeks to accomplish a similar goal, and to employ best practices in STEM education, but will focus on minorities in STEM at partnering small colleges/universities and their surrounding high schools, recognizing the importance of inter-institutional cooperation and the factors that influence success in academic STEM. The coordinated efforts of the PUMA-STEM Coalition will lead to improved academic and social integration of underrepresented minorities in STEM, as well as improved STEM professionalization, defined by the LSAMP model (Clewell, et al., 2005).

D.1.b. Coalition Coordination

Established in 1966, Associated Colleges of the Chicago Area (ACCA) consists of fifteen liberal arts colleges and universities most of which are located in the northern section of Illinois (outside Chicago). Although the need exists, no multi-institution collaborations among ACCA schools have been established to specifically benefit underrepresented minorities in STEM. In a recent study of out-of-school STEM-based programs in Chicago, reviewers found that there was a lack of coordinated efforts among the over 500 programs surveyed (Lyon, 2013). Survey results also found that few programs involved mentoring or internships, and that technical skills or career readiness was not encouraged, thus minimizing the growth of underrepresented minorities in STEM employment. The creation of the PUMA-STEM Coalition will facilitate the coordination of strategies and educational mechanisms that will provide measurable growth in the percentages of underrepresented minorities in STEM programming and careers.

Prior NSF Support

The lead institution and PI and Co-PIs for this proposal have received no NSF-LSAMP funding in the past five years.

<u>Structure and Organization of the Coalition</u>

The Coalition (PUMA-STEM) will be developed as a comprehensive pathway by which minority students underrepresented in STEM fields can achieve success in baccalaureate

programs and, ultimately, careers in STEM. As enrollment of underrepresented minorities is increasing in smaller colleges and universities rather than larger institutions (Carnevale & Strohl, 2013; Swail, 2003), it is important to have a strong network of partnering educational organizations at this level to address the needs of this cohort in STEM programming. The ultimate benefit of this network is that programming can be created to directly meet the specific demographics of the local communities. In accord with the mission of the LSAMP (Clewell, et al., 2005), the PUMA-STEM Coalition has a well-defined plan, institutional and faculty support, strong collaborative relationships among partners, and the capacity to provide the integrated services that comprise the LSAMP model.

PUMA-STEM Personnel	
Individual	**Role**
Christopher S. Reigstad, Ph.D., *Principal Investigator, Associate Professor of Biology, Concordia University Chicago*	• Oversee planning activities, manage partner cooperation and sustainability efforts • Coordinate work of Co-PIs • Network with surrounding schools and community • Document and disseminate program activities
Christopher Anderson, *Co-PI, Assistant Professor of Biology, Dominican University*	• Develop pathways to STEM graduate programs for underrepresented minorities • Contribute to peer-reviewed publications and other dissemination products related to PUMA-STEM
Victor Govindaswamy, Ph.D., *Co-PI, Associate Professor of Computer Science, Concordia University Chicago*	• Assist in technological outreach • Contribute prior experience related to Upward Bound and technology camps for at-risk high school students • Guide outreach to underserved populations
Matthew Kirkpatrick, *Co-PI, Division Head of Science & Technology, Oak Park River Forest High School*	• Coordinate collegiate and high school partnerships • Expand dual credit programs to benefit underrepresented minorities in STEM • Program developer at the high school level
Eve M. Mellgren, *Co-PI, Assistant Professor of Biology, Elmhurst College*	• Develop and promote idea transfer among PUMA-STEM affiliates • Outreach coordinator • Contribute to dissemination products related to PUMA-STEM
Amy Paulus, *Co-PI, Counselor, Proviso Math & Science Academy*	• Develop successful pathways for underrepresented minorities from high school to college programs in STEM • Identify areas for improvement regarding college readiness and student support for high schoolers in STEM
Charles Zona, *Co-PI, Dean, Hooke College of Applied Sciences and The McCrone Group, Inc.*	• Expand microscopy outreach to students • Develop online microscopy training and education • Promote career opportunities for undergraduate minorities in STEM

Participating Coalition Institutions

There are six institutions that will be participating in the investigation and planning of the network foundations. These institutions are representative of the student, university and community demographics in the network area.

Concordia University Chicago

Concordia University Chicago is a four-year private, liberal arts-based university located ten miles west of Chicago. It has a total enrollment over 5,000. Concordia is considered a Hispanic-serving institution with an enrollment rate of 25.8%. 100% of full-time undergraduate students receive some type of financial assistance based on need, merit, background and/or academic program.

Dominican University

Dominican University is a private, not-for-profit, coed higher education institution located ten miles west of Chicago. It has a total student population of 3,696 students (graduate and undergraduate) of which over 55% are considered minorities. 33% of the total student enrollment are Hispanic. More than 90 percent of freshmen receive some form of financial aid.

Elmhurst College

Elmhurst is a private, four-year college located sixteen miles west of Chicago. Its total student population is 3,257 (undergraduate and graduate). Of the entire undergraduate student body, 29% classify themselves ethnically as minorities; 15% are Hispanic. Financial aid was awarded to approximately 97% of the student population.

Hooke College for the Applied Sciences

Hooke College of Applied Sciences offers regularly scheduled courses and custom courses in light microscopy, electron microscopy, IR and Raman spectroscopy, and sample preparation. The campus is located 20 miles west of downtown Chicago in Westmont, Illinois.

Oak Park River Forest High School

This single-school district public high school serves over 3,300 students from the diverse communities of Oak Park and River Forest, Ill. The high school offers more than 200 academically rigorous courses in nine academic divisions at transition, college preparatory, honors, and Advanced Placement levels. Demographics indicate 21% are considered low-income/Title 1 and 43% of the student body identify as a minority.

Proviso Math and Science Academy

Proviso Math and Science Academy is located in Forest Park, twelve miles west of Chicago. It was founded in 2005 as a select enrollment academy, accepting students from all 10 feeder communities. It currently has 821 students, 91% of whom identify ethnically as a minority. 53% of the student body are Hispanic and 40% are considered low income.

During the timeframe of the project, it is a goal to expand the network to include area STEM industry leaders as well as additional academic institutions.

Project Goals

The goals of this Pre-alliance Planning Project are:

- To create a coordinated strategic network of school districts, small colleges and universities, and STEM businesses focused on the issues of underrepresented minorities in STEM programming
- To plan activities that will engage students in STEM programming with the aim to foster increased participation rates of students in STEM high school classes, promote ethnic diversity of enrollment in STEM majors at the university level, and improve the graduation rate into STEM-related employment
- To develop mentorships among students, faculty, & professional role models, within and outside the learning environment to promote the development of STEM interest and skills
- To analyze data to better understand the relationships between the demographics, curriculum, support programs and recruitment/retention/graduation of students in STEM programming
- To research and design methods to incorporate best practice pedagogy into current programming to increase success rate of underrepresented minorities in STEM
- To communicate results and plan future outreach and expanded planning with area school districts, colleges, universities and STEM businesses through diverse modes of communication

Proposed Planning Activities

PUMA-STEM Coalition Proposed Planning Timetable						
	2016		2017			
Activity	7/1-9/30	10/1-12/30	1/1-3/30	4/1-6/30	7/1-9/30	10/1-12/30
Initial Meeting						
Evaluation of Existing Programs						
Demographic/Cultural Analysis of Student Populations						
Analysis of Financial Barriers for Students						
College Readiness Workshop						
Recruitment/Retention Workshop						
Dual Credit Workshop						
Student Mentorship Workshop						
Career Services Workshop						
Business Partner Networking						
Creation of Active-learning Research Programs						
Creation of Dissemination Platforms						
Determination of Ancillary Funding						

All planning topics and activities will be reviewed and assessed through five predominant principles:

Demographic Need

Factor is missing, or is severely lacking thereby contributing to deficit in STEM programming, recruitment or retention

Verification

Factor has established significant research validating best practice and pedagogical support leading to demonstrated improvement

Feasibility and Sustainability

Factor can be appropriately and capably implemented and sustained by the institution (including fiscal, personnel, and building constraints)

Viability for Expansion

Factor can be implemented by institutions throughout current network and future expanded system.

Strategic

Factor can be implemented in a coordinated strategic manner through the coalition, thereby strengthening the overall network.

PUMA-STEM Coalition Activities, Goals and Outcomes		
Activity	**Goals**	**Outcome**
Initial Meeting	Establish specifics of planning activities and discuss perceived areas for improvement and desired outcomes for individual sites	Identify top three perceived areas for improvement for each academic partner
Evaluation of Existing Programs	Evaluate success of current retention/recruitment activities and financial impact to PUMA-STEM institutions	Develop surveys to characterize and quantify Goals (at left); generate data to assess established programs
Demographic/Cultural Analysis of Student Populations	Analysis of baseline data and community/state/federal census data; Survey of high school administration and institutions for perceived cultural barriers to college entrance and graduation rates	Analysis report of survey and demographic data; develop plan for mentorship programs to ameliorate cultural barriers
Analysis of Financial Barriers for Students	Study of institutional financial aid award rates; better understand costs and benefits for students	Produce document to increase ease of financial aid process and student/family knowledge of process

College Readiness Workshop	Evaluate and coordinate adoption of empirically validated teaching practices; Discuss potential for summer programs to improve high school transition to STEM programs	Create a plan to reduce need for remedial training among college freshmen in STEM
Recruitment/Retention Workshop	Assess enrollment and retention rates at each institution and discuss needed steps to benefit underrepresented minorities based on best practices and resource availability; expansion of Student Visit Days, College Fairs	Produce report of the common and site-specific areas for improvement among STEM programs for underrepresented minorities
Dual Credit Workshop	School to campus programs; Campus to school programs; Evaluate benefits and obstacles to training high school teachers as adjunct faculty to create accessible dual-credit programs and address teacher training concerns	Initiate PUMA-STEM efforts to establish more dual credit opportunities for high schoolers and credit transfers from community colleges
Student Mentorship Workshop	Investigate and create college student-to-high school student mentors program and business to college student mentorship program utilizing a demographic/cultural pairing model	Develop new strategies to recruit ethnically diverse student and professional mentors
Career/Graduate Services Workshop	Explore current STEM-business network possibilities for mentorship, internships and externships, and participation in inquiry-based learning opportunities	Initial development of deliverable document identifying career and graduate programs for students with special attention to opportunities available to underrepresented minorities
Business Partner Networking	Establish additional partnership opportunities for professional mentorships, internships, externships and resource development	Create report of business outreach from PUMA-STEM; Document and improve coordination with business/industry
Expansion of Inquiry-based Learning and Research Programs	Investigate current successful models; Determine capacity for implementation; Research potential modalities for implementation	Report on intra- and inter-institutional approaches to inquiry-based and active learning, as well as research in STEM

Creation of Dissemination Platforms	Establish central PUMA-STEM resource website for students, teachers, and administrators; cultivate social media presence to increase underrepresented minorities in STEM	Live, functional website; Participation in area conferences; presentations at local schools
Determination of Ancillary Funding	Consolidate inter-institutional connections related to prospective funding sources, sponsorship, and sustainability of PUMA-STEM	Initiation of further grant proposals, fundraising, and sponsorship interactions

Institutional Support and Sustainability Plan

The proposed Coalition has the institutional support of all participating organizations as indicated by the Letters of Commitment included in this submission. Outreach and recruitment events may be held at various ACCA affiliates, local high schools, or other locations; however, unless otherwise decided upon by the Co-PIs, Coalition activities (meetings, workshops, etc.) will commence at Concordia University Chicago.

Efforts to secure additional funding for PUMA-STEM are integral to this proposal and outreach to local STEM-related businesses and industries will continue as a means to facilitate STEM internships and externships for underrepresented minorities, to involve culturally familiar professional mentors, and to raise additional funds for industry-sponsored PUMA-STEM activities and events., All Co-PIs and their home institutions are committed to tracking and improving participation and success of underrepresented minorities in their respective STEM programs.

High school and college/university administrators at each institution recognize the need for this program and support its deployment. If this Pre-Alliance Planning project is funded, continued institutional support and success of PUMA-STEM will enable construction of a coordinated, and collaborative effort to achieve the long-term impact described in the appended Logic Model strengthened and expanded academic coalitions employing effective approaches to increase participation and success of underrepresented minorities in STEM.

Data Management Plan

Demographic and programmatic data, including but not limited to all items in the baseline tables submitted with this proposal, will be tracked longitudinally at each institution. Data not tracked in the baseline enrollment demographics for partnering institutions at the time of this submission will be assessed moving forward. This will facilitate a prospective view of trends at each institution and real-time approaches employable to improve recruitment, retention and graduation rates of underrepresented minorities in STEM.

Enrollment, retention, demographic, and other data will be funneled from Admissions Offices, Institutional Research Offices, or other relevant office at each partner, to Dr. Reigstad (PI) and the proposed *External Evaluator* for this project, Mr. John H. Schwartz, Coordinator of Assessment and Accreditation at Concordia University Chicago. Collection time points or checkpoints for demographic data of STEM majors and programs will occur approximately

every three months, beginning with the first funded project quarter. Six time points for additional demographic data collection will be assessed in the 18-month funding period. Initial data have been obtained and included for institutional partners on this grant, so prospective tracking of demographic and success statistics will be deliverable if this proposal is funded. Tracking student demographic data with progress pre- and post-graduation will allow for the dissemination of reports concerning academic progress and downstream employment in STEM.

Numerical and tabular data will be stored in a Google Docs spreadsheet available to be read and analyzed by all Co-PIs on the project. Program data (e.g., enrollment demographics, graduation statistics) will be analyzed and discussed as they becomes available from each institution to facilitate identification of new directions and improvements that may be beneficial. Statistical analysis of data collected through PUMA-STEM activities will guide the development of a comprehensive strategic plan among academic and business entities to reduce obstacles that impede growth of underrepresented minorities in STEM. Furthermore, PUMA-STEM data will be assessed in relation to national data and those of other comparable regions and/or organizations. Highlighted below are specific PUMA-STEM goals related to data collection, analysis, and discussion:

- Compare demographic data from communities surrounding partnering sites
- Compare demographic data of existing programs intended to benefit minorities and first generation students
- Assess current financial aid and support to students among partners
- Review best practice and research for STEM pedagogy
- Assess post-graduate employment/career data
- Quantify partner and surrounding high school graduation rates related to underrepresented minorities in STEM
- Compare enrollment statistics in different STEM programs
- Compare attrition rates among minorities in partnering STEM programs
- Determine current extent of dual credit stem coursework at PUMA-STEM secondary institutions and credit transfer among two- and four-year institutions

Associative statistical comparisons will be performed using the variables described above (ANOVA with *ad hoc* statistical tests). This will, in turn, facilitate identification of key strategies for improving participation and success in STEM among high school and college students from underrepresented minority groups.

Evaluation Plan

Mr. John H. Schwartz, Coordinator of Assessment and Accreditation, will serve as the *External Evaluator* for this project. Mr. Schwartz has extensive experience in educational research, validation of research processes, and analysis and interpretation of research data. Mr. Schwartz's prior experiences include work on a NSF-funded study at Northern Illinois University testing the impact of targeted treatments in middle and high school science classrooms on interest, engagement and achievement of underrepresented students in science (Grant No: HRD-1136143), as well as review and evaluation of the curriculum of an existing College Readiness

course, and a research study evaluating the cognitive processing of self-report items as part of a larger National Center for Educational Research study to develop a reliable and valid measure of adolescent reading motivation (Award # R305A110148). In addition, Mr. Schwartz has experience developing college readiness workshops, and developing and analyzing survey results. Thus, his expertise relates directly to the goals and objectives of this proposal. Mr. Schwartz will adhere to the American Evaluation Association's Guiding Principles for Evaluators (American Evaluation Association, 2004). Formative and summative evaluation of the Coalition for PUMA-STEM will be consistent with the standards established by the Joint Committee on Standards for Educational Evaluation (Yarbrough, Shulha, Hopson, & Caruthers, 2011).

Mr. Schwartz will determine whether the proposed activities are being performed in a timely manner and whether satisfactory progress toward the 13 described Outcomes are being achieved. In addition to evaluation of individual interventions, formative and summative evaluations, described below, will include holistic assessments of the collaboration/partnership among PUMA-STEM affiliates.

Deliverables and activities of PUMA-STEM, as well as institutional data from each affiliate, will be made available to the *Evaluator* for rigorous evaluation based on multiple benchmarks/indicators relative to activities and expected outcomes. Indicators will include completion of meetings and workshops outlined in the table above: PUMA-STEM Coalition Activities, Goals and Outcomes. The Logic of this project indicates the suggested progress and successful outcomes.

Mr. Schwartz will provide a summative evaluation of project effectiveness and identify positive and constructive findings when the project is completed. Dr. Reigstad (PI) will provide evaluation feedback to the Co-PIs as it becomes available to discuss possible improvements to the project and coordinate reporting of external reviews. Clear indicators of progress will serve to inform reviewers of the PUMA-STEM's understanding of essential recruitment and retention factors related to (i) enrollment and baccalaureate degree production of underrepresented groups, and (ii) the process of change in organizational culture, impact and progress in developing highly competitive, well-prepared STEM students.

Formative Evaluation:

Each Outcome will be measured on a scale of zero-to-three (0-3) with zero representing no progress and three representing completion or excellent progress toward the Outcome in question (see Outcomes Table). The final evaluation will indicate an earned score relative to 36 possible "points"—12 Outcomes x 3 points (max). A score of 1 for a given Outcome will indicate unsatisfactory progress; a score of 2 for a given Outcome will indicate satisfactory (but less than optimum) progress toward the Goal. A rubric will be designed to accurately assess the progress of each Outcome and provide indicators for improvement for those Outcomes earing a score less than 3.

When available, metrics to be used in project monitoring will include: pre-college STEM exposure (e.g., number of high school STEM courses) and grades based on high school transcripts, number and proportion of underrepresented minorities (African-American, Hispanic,

and indigenous American, as well as Pacific Islander) in STEM programs at affiliated colleges/universities, percentage of underrepresented minorities in STEM programs.

Retention and graduation rates in STEM will be tracked for each PUMA-STEM affiliate. Initial data have been obtained and included for institutional partners on this grant, so prospective tracking of demographic and success statistics will be delivered if this proposal is funded. Planning activities will include development of approaches to track students pre- and post-graduation, and to gauge academic progress, employment rates of former students in STEM, and progress to STEM graduate programs. These data will be made available to the Co-PIs through appropriate Offices at each institutional partner and compiled for evaluation by alliance partners and the public.

Several mechanisms will be developed to ensure that this program is effective in planning activities geared toward recruiting and retaining underrepresented minorities in academic STEM programs. As indicated in the timeline, PUMA-STEM affiliates will meet to discuss data, programs and research regarding minorities in STEM within area schools (and surrounding schools where these data are available), demographic analyses of the surrounding student population, as well as less quantifiable aspects of program development and successes within each organization. Planning activities made possible through LSAMP will facilitate workshops and meetings to best incorporate suggestions and ideas from STEM educators at each of the partnering institutions to improve the experiences, participation, and success of underrepresented minorities in STEM.

Dissemination Plan

All planning activities, meetings, and workshops will be documented through assembly of Meeting Minutes and/or Summaries which will generated by Dr. Reigstad or other PI. These documents, like program and demographic data, will be made available to all Co-PIs, the *External Evaluator*, the NSF/LSAMP, and the public through a dedicated website. Longitudinal data procured and compiled by the Coalition will include changes in demographic information regarding the ethnic diversity among STEM programs at the academic institutions in PUMA-STEM. Coalition reports will analyze and discuss relevant educational and demographic trends among PUMA-STEM affiliates and best practices to promote improvement in STEM program diversity within the different academic sites. These data, as well as the results of statistical analyses and group discussions, will be formally prepared for dissemination.

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FACILITIES, EQUIPMENT & OTHER RESOURCES

FACILITIES: Identify the facilities to be used at each performance site listed and, as appropriate, indicate their capacities, pertinent capabilities, relative proximity, and extent of availability to the project. Use "Other" to describe the facilities at any other performance sites listed and at sites for field studies. Use additional pages if necessary.

Laboratory: N/A

Clinical: N/A

Animal: N/A

Computer:
Concordia University Chicago provides computers and technical support for all Concordia University faculty members. Concordia University Chicago will also provide network access, computer-related support, cloud storage and back up, statistical/data and document-based software, and computers as required for this project.

Collaborating institutions will provide their own computer hardware for use by their respective Co-PIs.

Office:
Concordia University Chicago will provide for all printing and photocopying through the university print shop and department printers.

Other:
Meeting venueConcordia University Chicago will provide meeting space for all project-related events.

MAJOR EQUIPMENT: N/A

OTHER RESOURCES: N/A

Data Management Plan

Demographic and programmatic data, including but not limited to all items in the baseline tables submitted with this proposal, will be tracked longitudinally at each institution. Data not tracked in the baseline enrollment demographics for partnering institutions at the time of this submission will be assessed moving forward. This will facilitate a prospective view of trends at each institution and real-time approaches employable to improve recruitment, retention and graduation rates of underrepresented minorities in STEM.

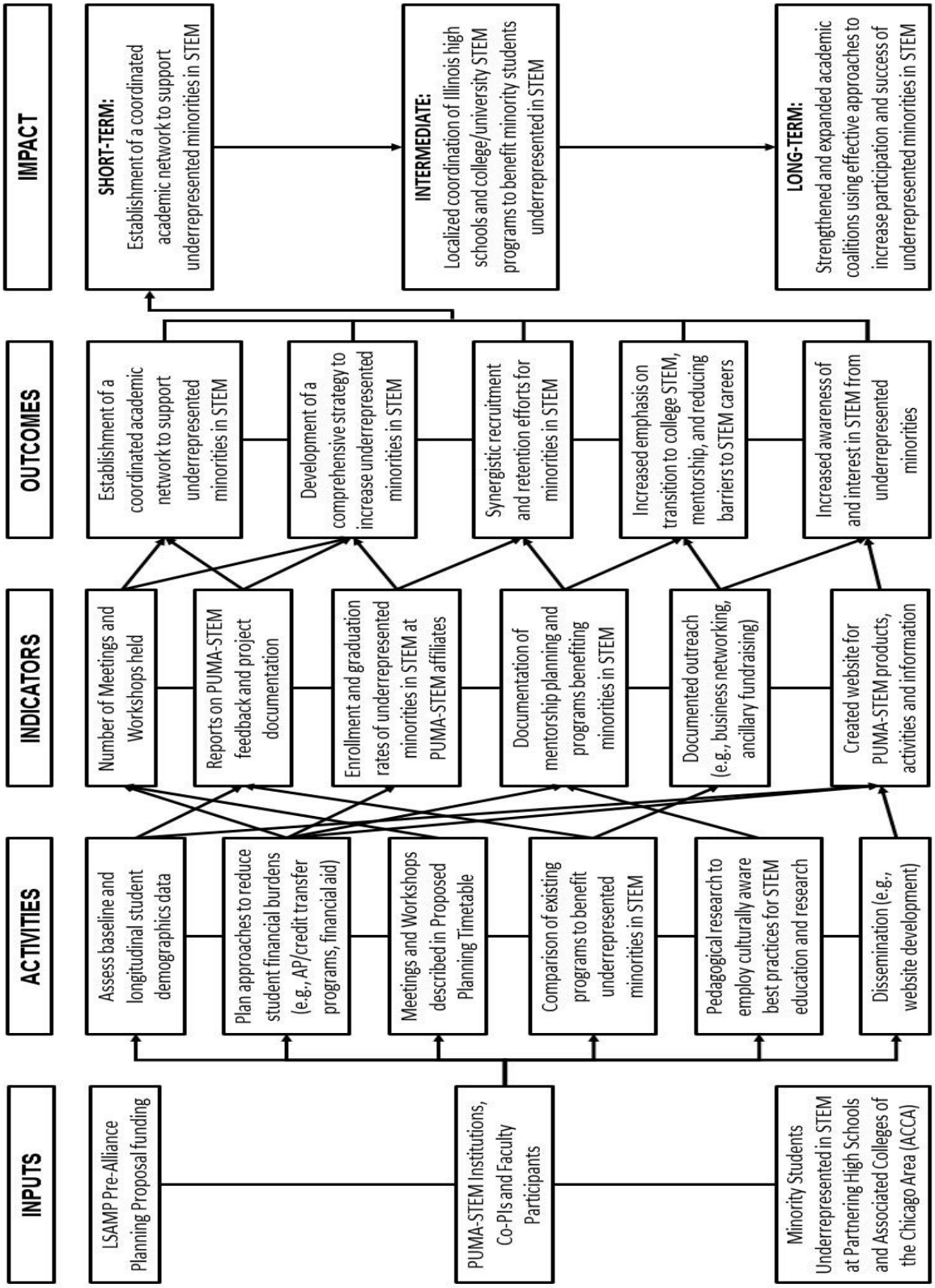
Enrollment, retention, demographic, and other data will be funneled from Admissions Offices, Institutional Research Offices, or other relevant office at each partner, to Dr. Reigstad (PI) and the proposed *External Evaluator* for this project, Mr. John H. Schwartz, Coordinator of Assessment and Accreditation at Concordia University Chicago. Collection time points or checkpoints for demographic data of STEM majors and programs will occur approximately every three months, beginning with the first funded project quarter. Six time points for additional demographic data collection will be assessed in the 18-month funding period. Initial data have been obtained and included for institutional partners on this grant, so prospective tracking of demographic and success statistics will be deliverable if this proposal is funded. Tracking student demographic data with progress pre- and post-graduation will allow for the dissemination of reports concerning academic progress and downstream employment in STEM.

Numerical and tabular data will be stored in a Google Docs spreadsheet available to be read and analyzed by all Co-PIs on the project. Program data (e.g., enrollment demographics, graduation statistics) will be analyzed and discussed as they becomes available from each institution to facilitate identification of new directions and improvements that may be beneficial. Statistical analysis of data collected through PUMA-STEM activities will guide the development of a comprehensive strategic plan among academic and business entities to reduce obstacles that impede growth of underrepresented minorities in STEM. Furthermore, PUMA-STEM data will be assessed in relation to national data and those of other comparable regions and/or organizations. Highlighted below are specific PUMA-STEM goals related to data collection, analysis, and discussion:

- Compare demographic data from communities surrounding partnering sites
- Compare demographic data of existing programs intended to benefit minorities and first generation students
- Assess current financial aid and support to students among partners
- Review best practice and research for STEM pedagogy
- Assess post-graduate employment/career data
- Quantify partner and surrounding high school graduation rates related to underrepresented minorities in STEM
- Compare enrollment statistics in different STEM programs
- Compare attrition rates among minorities in partnering STEM programs
- Determine current extent of dual credit stem coursework at PUMA-STEM secondary institutions and credit transfer among two- and four-year institutions

Associative statistical comparisons will be performed using the variables described above (ANOVA with *ad hoc* statistical tests). This will, in turn, facilitate identification of key strategies for improving participation and success in STEM among high school and college students from underrepresented minority groups.

SUPPLEMENTARY DOCUMENT I: LOGIC MODEL



Revised Timeline for PUMA-STEM Planning Activities (NSF Award Number 1612767)

Revised PUMA-STEM Planning Timetable						
Activity	**9/1/16-11/30/16**	**12/1/16-2/28/17**	**3/1/17-5/31/17**	**6/1/17-8/31/17**	**9/1/17-11/30/17**	**12/1/17-2/28/18**
Initial Meeting						
Evaluation of Existing Programs						
Demographic/Cultural Analysis of Student Populations						
Analysis of Financial Barriers for Students						
College Readiness Workshop						
Recruitment/Retention Workshop						
Dual Credit Workshop						
Student Mentorship Workshop						
Career Services Workshop						
Business Partner Networking						
Creation of Active-learning Research Programs						
Creation of Dissemination Platforms						
Determination of Ancillary Funding						