2016 HAWAII UNIVERSITY INTERNATIONAL CONFERENCES
SCIENCE, TECHNOLOGY, ENGINEERING, ART, MATH & EDUCATION JUNE 10 - 12, 2016
HAWAII PRINCE HOTEL WAIKIKI, HONOLULU

UHD STEM COMMUNITY TRANSFORMATION - TAKING MENTORING ACROSS A COLLEGE

PARKER, MARY JO
UNIVERSITY OF HOUSTON-DOWNTOWN
SCHOLARS ACADEMY/NATURAL SCIENCES DEPARTMENT

Dr. Mary Jo Parker
Scholars Academy/Natural Sciences Dept.
University of Houston-Downtown.

UHD STEM Community Transformation – Taking Mentoring Across a College

Synopsis:

The University of Houston-Downtown's Scholars Academy has generated over 700 alumni STEM graduates of which 91% remain in STEM graduate programs and/or the workforce following completion through its program impacting 160 undergraduates per semester. STEM student successes are supported through a small group mentoring model. How can this successful peer and faculty mentoring structure be expanded to effect positive change and success across an entire college comprised of 1500 STEM majors?

Dr. Dilley de Garcia/Parker, Mary Jo
Natural Sciences / Scholars Academy/ University of Houston, Downtown
UHD STEM Community Transformation – Taking Mentoring Across a College

Abstract:

The University of Houston-Downtown's Scholars Academy has generated over 750 alumni STEM graduates of which 91% remain in STEM graduate programs and/or the workforce following completion through its program impacting 160 undergraduates per semester. STEM student successes are supported through a small group mentoring model. How can this successful peer and faculty mentoring structure be expanded to effect positive change and success across an entire college comprised of 1500 STEM majors?

Through application of a design to impact an entire college of science and technology, the design plan is grounded in a 16-year program model (UHD Scholars Academy), thereby providing basis for the design factors which will form the needed infrastructure to positively impact the persistence of minorities and women into STEM workforce careers as a result of salient features. By incorporating these salient features, great strides in supporting all STEM students can occur. Salient features include: 1) Create core discipline-based STEM communities through established student "clubs"/ organizations; 2) Engage, incorporate all faculty members (junior/senior) as mentors within the club discipline STEM communities; 3) Use the Scholars Academy (SA) as the template for operationalizing the five most impactful retention actions they support; 4) Use the UHD SA Peer Mentor Training Retreat as a model for training discipline-based club officers as lead peer mentor leaders; 5) Provide academic support through tutoring of lower/upper division coursework using a peer-led team-learning model.

Content:

The UHD Scholars Academy (SA), a unit in the College of Sciences and Technology, established in 1999 as a structural mechanism supporting science, technology, engineering, and mathematics (STEM) undergraduates, especially minority STEM undergraduates. In this 16th year of the Scholars Academy's existence, the SA offers a successful, effective model of scholarship, mentorship, service, leadership/career development, and mentored research which will provide *key components essential to the transformation project*. Over the past 16 years the SA has demonstrated that an intentional support system can work to retain and graduate minority and women STEM majors. Evidence of the programs benchmarks of excellence can be seen in the following data: 1) SA has graduated over 750 STEM alumni over 16 years; 2) Established a current 51% acceptance rate of its membership into medical schools; 3) Supported a current rate (and rising trend) of acceptance into graduate and professional schools of 41%; 4) Supported entry of STEM graduates into the STEM workforce at a rate of 52% up from 46% in 2009; and 5) Evidences a rate of 93% of all SA STEM graduates remaining in STEM pipeline either through graduate/professional programs and/or entrance into the STEM workforce post-baccalaureate. SA currently evidences a 57% six-year graduation of first-time-in-college (FTIC) undergraduates and a 69% retention rate from year one to year two of the four year undergraduate experience.

While UHD, an Hispanic and Minority Serving Institution (80% minority enrollment) with about 60% first generation students, is proud of SA STEM successes, these successes remain attributable to only a small fraction (approximately 20%) of the entire College of Science and Technology STEM community population. The mandate of the *STEM Community Transformation* project is to complement the efforts of the SA by applying key components across the entirety of the College of Science and Technology to blanket *ALL STEM majors* with the support connected to the SA's amazing student/program successes.

UHD Scholars Academy Program Components Provide a Model for the *STEM Community Transformation*

Programmatically, the Scholars Academy (SA) is an academically competitive program in UHD's College of Science and Technology (CST) that promotes scholarship and a system of support for student success targeting qualifying STEM undergraduates (approximately 160-185 annually). SA utilizes an established a multi-point STEM program of support yielding not only student success, but also offers a template for replication. The multi-point model includes: Point 1: Scholarship Support assisting full –time student status; Point 2: Mentoring - PhD faculty and peer mentors; Point 3: Seminar/Field trips as broadening experiences and career enhancement; Point 4: Graduate School/Workforce Preparation in the form of CV and Personal Statement development; and Point 5: Exposure to In-house & External Research/Internship opportunities. The SA program model also includes: Point 6- JUMPSTART Research early summer workshop led by PhD researchers in the first two years of university; Point 7- Pre-College START early fall followed by a core seminar course creating a cohort group; Point 8- Research dissemination support; Point 9- Mentor (FM/PM) Training; and Point 10- Academic tutoring support for all lower and upper division STEM disciplines including natural sciences, computer science, mathematics, and engineering technology.

Scholarly Rationale Used in Identifying the Five SA Success Components for the STEM Community Transformation Project: Research provides the rationale for the five success components deemed essential for STEM Community Transformation project. Kuh (2008) attributes high impact educational practices to student retention, connections to learning outcomes, and achievement [Key Components - Service & Community-based Learning; Learning communities]. Tinto (1987) has long professed actions which work to improve student retention through transition assistance, community building, academic involvement/support, and counseling/advising [Key Components – Community Service; Discipline-based mentoring groups; Tutoring for academic support; Faculty/Peer Mentoring]. Edzie & Alahmad (2013), (Christe, 2013) and Kendricks, Nedunuri, & Arment, (2013) discuss mentoring by peers, faculty, and others in assisting STEM students in linking to their majors, increasing stronger relationships increased levels of positive outcomes, and enhancing academic performance [Key Components – Faculty/Peer Mentoring; Tutoring for academic support]. Streitwieser & Light (2010) describe the impact and benefits of peer-led team learning contextualized within STEM disciplines; training of the peer leaders was also deemed important to project affinity [Training Mentors].

Based on research rationale and underscored by a minimalistic budget approach in relation to the expansion for transformation, thereby encouraging a cost-effective and impactful transformation process, *five, salient* SA *success components have been determined as key* to the *UHD STEM Transformation* process impact: 1) *Faculty and peer mentoring* based on disciplines; 2) *Broadening career experiences* for STEM undergraduates based on disciplines in the form of seminars and fieldtrips; 3) *Small learning communities grounded in discipline-based groups*, formed by current student STEM clubs/organizations, where mentoring, career preparatory activities will take place; 4) *Training the peer mentors* through a retreat process—lead peer mentors will be selected from SA START (a summer pre-university workshop) program freshman/transfers and from club President/VP individuals; and **5)** *Tutoring academic support* for closing the academic/knowledge gap frequently found among minority/first generation learners (Tinto, 1987; Christe, 2013; Vogt, 2008; Sanchez, Bauer, & Paronto, 2006;). See Figure 1 illustrating the transformation project.

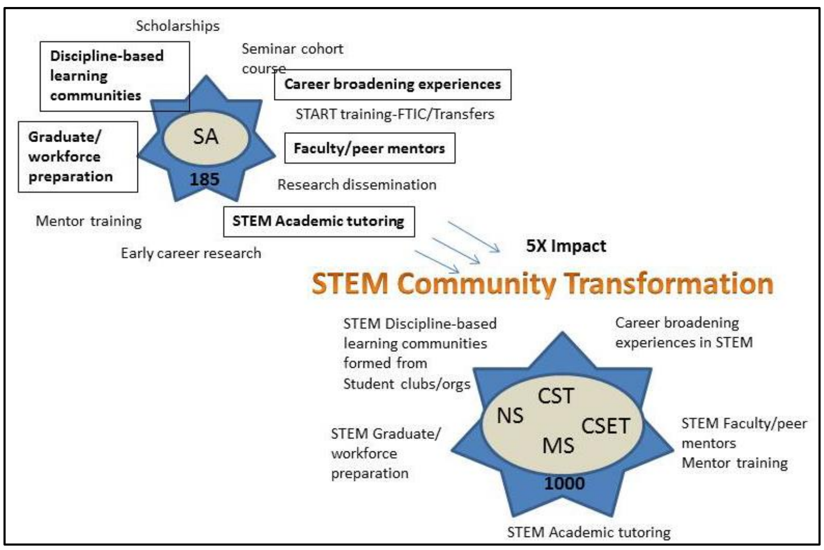

Figure 1. STEM community transformation - five key components supporting all STEM majors.

This comprehensive model across STEM disciplines will provide much needed evidenced-based project effectiveness useful to institutions considering implementation improving for their STEM minority and female population retention and graduation. Results from this project will offer potential transformation for the undergraduate experience and transferability to other non-STEM departments across the university which may be considering implementation of evidence-based components targeting improved and impactful persistence of critical populations. Finally, and most urgently, the objectives from this study will yield results that will directly and positively impact institutional STEM practices in support of increasing minority demographics into the workforce and improving STEM graduates.

General Need for this Approach

Based on current demographics, Hispanics are likely to become the major ethnic group in Texas by 2030, thus there is need for Texas and the U.S. to close the science education gap, recruit more Hispanic students and other minorities into, graduating from, and persisting beyond, university STEM degree programs. A clear need exists for more minority undergraduate students across natural sciences, computer and mathematical sciences, and engineering technology degree emphasis to enroll in and complete STEM degrees, thereby lessening an educational attainment gap evidenced among minorities. At UHD this includes all degree majors within the College of Sciences and Technology. While increasing the pipeline of minority students entering baccalaureate degrees is urgent and related to the need for familiarity with the college experience, once entered into college, minority undergraduates need encouragement not only persistence to graduation, but to persistence into graduate/professional and the STEM workforce following graduation. Thus, exposure to discipline-based undergraduate small learning communities supports persistence into STEM careers, expressly needed for minorities and women, many of whom are first-generation learners.

Minority students and women continue to dismiss the four-year university out of fear of the unknown prior to entrance. Minorities, particularly minority women, continue to fail-out of first-year barrier STEM courses as a result of no substantive support services, lack of adequate pre-college preparatory coursework, and/or little to no acculturation into the study hours and techniques needed to grasp rigorous STEM topics as presented in first year courses. First generation minority students, in particular, have little to no historical, familial connections to what collegiate expectations are for STEM students, thus have the least supportive network available to them once entrance into the STEM degree curriculum begins. This project aims to increase the success rate of minority students, particularly minority women, choosing STEM degrees and continuing to persist in college and into STEM careers and the workforce.

Operationalizing Mentoring to the larger STEM college community

Five key components from the SA program serve as the foundational elements for this project. The *five* SA *success components which have been determined as key* to the UHD STEM Transformation project include: 1) *Faculty and peer mentoring* based on disciplines; 2) *Broadening career experiences* for STEM undergraduates based on disciplines in the form of seminars and fieldtrips; 3) *Small learning communities grounded in discipline-based groups using service activities*, formed by current student STEM clubs/organizations, where mentoring, career preparatory activities will take place; additional summer workshop exposure to the PhD's research lab will occur; 4) *Training the peer mentors to ensure fidelity* through a retreat process—lead peer mentors will be selected from SA START (a summer pre-university workshop) program freshman/transfers and from club President/VP individuals and trained off-site by the project's Lead Peer Mentor Coordinator; and 5) *Academic tutoring* support for lower and upper division STEM courses across CST.

We have recognized several predominant barriers and distinctive benefits and advantages to providing discipline-based mentored small group experiences to undergraduate students, minority and women included, as they pursue STEM degrees. These *barriers* potentially include the ratio of PhD faculty to undergraduates within the disciplines and the willingness of all CST faculty to participate in this important support of all STEM undergraduates. The *benefits* are recognized as evidenced by the SA program over the past 15 years to include: 1) increased retention, 2) increased on-time graduation, 3) increased post-baccalaureate STEM persistence, 4) increased connections to PhD professors through the small groups and strong peer influence, often resulting in opportunities for mentored research on and off campus, and 5) increased academic support in barrier and upper division courses sustaining the GPA. This project expects the categorical impact of PhD mentored, discipline-based small learning community experiences on STEM minority and women students in pursuing the baccalaureate and beyond the baccalaureate.

Goals in transforming the college community

The primary goal of this project is *a transformational infrastructure supporting undergraduate success for STEM discipline majors across the entire college of science and technology.* This is possible when key components and infrastructure of the successful SA program are incorporated as foundational mechanisms of student support addressing all students across all STEM disciplines. Evidenced impacts of this community transformation throughout the four-year undergraduate experience will encourage and prepare ongoing STEM persistence at and beyond the baccalaureate level. Secondly, this project's goal is to evaluate in a mixed method design, the effectiveness of PhD-mentored discipline-based STEM small learning communities formed from existing infrastructure, i.e., discipline-based student clubs/organizations as well as to examine attitudes and perceptions associated with transformation across minority STEM majors over the award period. The prior year's STEM major population will be used as the comparison group along with the prior year's SA membership, which has well-established levels of reported retention and graduation rates.

In order to meet the project goals we propose tracking STEM undergraduates by Faculty-led mentor group each semester for: 1) career broadening attendance practices [# of attended field trips/seminars & attitudes expressed about these]; 2) barrier course grades; 3) tutoring attendance [frequency of attendance]; 4) small learning community attendance and completion of assigned activities [curriculum vitae/resume, personal statement, and learning about research]; 5) impact of community service and career broadening experiences on attitudes and knowledge toward STEM persistence and career [post-semester survey]; and 6) perceived confidence/preparation in continuance into post-baccalaureate STEM fields resulting from summer workshop and small learning communities [post-semester survey]. A bi-annual post-semester survey will be administered to all CST undergraduates electronically. The survey will be modeled after the SA post-semester survey in existence for 12 of the 15 years of this model program, thus supporting comparison of qualitative and quantitative evaluation elements (see evaluation piece).

Specific Activities and Management Plan to Meet Project

<u>Current STEM Student Organizations/Clubs form Infrastructure for STEM Small Learning Communities Facilitating Ongoing Faculty/Undergraduate Engagement</u>

The mentor group SA model for peer mentor group formation, existing discipline-based student STEM clubs/organizations will form a structural mentoring group, thus allowing for more than just the sponsoring faculty member/s to participate and forms a connection for all STEM majors by connecting them to their professed career discipline of study. All STEM faculty will affiliate and become PhD mentors to the discipline-based student clubs, thereby providing the mechanism for mentorship within the smaller group student club/organization.

Today, 12 STEM student club/organizations representing disciplines in the Natural Sciences, Mathematics, Engineering Technology, and Computer Science exist. Current clubs/organizations include: 1) AMSA [pre-medical]; 2) HPO [pre-health]; 3) ASDA [predental]; 4) Darwin-Leeuwenhoek Society [microbiology-evolution]; 5) Chemistry Club; 6) Geology; 7) Environmental; 8) JAMP [pre-medical]; 9) MAA [mathematics]; 10) ACM [computer science]; 11) ISA [pre-process engineering]; and 12) ACI [pre-structural engineering].

Using the discipline-based student clubs/organizations supports the involvement of all CST faculty membership as PhD mentors within their discipline-specific club. Currently, there are over 70 PhD faculty members across the Natural Sciences (NS) (34), Mathematics and Statistics (MS) (30), and Computer Science and Engineering Technology (CSET) (10) based on UHD Office of Effectiveness data (FactBook, 2013- 2014).

The CST STEM majors population is broken out into disciplines in the following manner: 1) Natural Sciences – 625 undergraduates; 2) Computer Science and Engineering Technology – 274 undergraduates; and 3) Mathematical Sciences – 107 undergraduates. When the number of STEM majors by discipline is associated with the number of potential PhD mentors per discipline (based on this project's model), disciplines ratios can be determined and adjusted based on the greatest number of STEM undergraduates within the university's majors (See Table 1). When ratios of PhDs to Majors by club/organization affiliation is reviewed, one finds slight differences in ratios (See Table 2), but sufficient distribution to the meet the demands of the needed infrastructure to bring about successful mentoring as outlined by the project. Because mentoring by like-gender role models is an important support mechanism for this project, data examining this feature was reviewed (Christe, 2013) offering the plausibility within this project seen in Table 3.

Table 1. Ratio of PhDs to Majors Per STEM Discipline.

Discipline-based PhD Mentors*	STEM Major Undergraduates (59.6% Female/40.4% Male)	Ratio of PhD to STEM Undergraduates
Natural Sciences (34)	625	1:18
CSET (10)	274	1: 27
MS (30)	107	1: 4

*Full-time tenure-track/tenured/lecturers comprise these PhD mentors.

Table 2. Ratio of PhD Mentors to Majors by STEM Club/Organization

STEM Club/Organization PhD Mentors	STEM Major Undergraduates	Ratio of PhD to Club/Organization Membership
NS - AMSA	105 (4 PhD)	1: 26
NS – HPO	105 (4 PhD)	1: 26
NS – ASDA	105 (4 PhD)	1: 26
NS – Geology	14 (2 PhD)	1: 7
NS – Environmental Science	56 (2 PhD)	1: 28
NS – JAMP	105 (3 PhD)	1: 35
NS – Chemistry Club	143 (10 PhD)	1: 14
CSET – ISA	149 (3 PhD)	1: 49
CSET – ACI	64 (2 PhD)	1: 32
CSET - ACM	210 (5 PhD)	1: 42
MS - MAA	107 (30 PhD)	1: 4

Table 3. Gender Role Models in the Context of STEM Community Transformation (Eccles, 1987).

Department	Gender-Male	Gender-Female
NS	19	15

CSET	9	1
MS	15	15

All discipline-based student clubs/organizations (mentor groups) will meet monthly (4-5 times per semester) with the discipline-based PhD assigned and the trained lead peer mentor; discipline-based groups will meet in a one-week summer workshop focused on understanding the PhD's research lab/research in general. Monthly meetings will bring a focused agenda providing mentorship, camaraderie, career broadening activities, group community service project execution, information as to the PhD's research labs. *Faculty PhD mentors* will bear the tasks of 1) providing mentorship during the monthly meetings; 2) assisting club members in development of a curriculum vitae and resume; 3) scheduling a field trip for the group/s; 4) ensuring to the group that all SA seminar presentation schedules are known and distributed; 5) participate in a jointly planned community service project, preferably discipline-based; and 6) assistance in group members completing an opportunity for research/internship on- or off-campus; an introduction begins with a one-week summer research workshop lead by the PhD. PhD Faculty Mentors will meet with the project's PI/Co-PI team twice a semester as a function of training and support of the mentors and the project. Each FM will submit a report related to accomplishments of the discipline-based small learning community.

Additionally, SA undergraduate members would be selected as *lead peer mentors* for each of the discipline-based group/s. SA members are required to hold higher grade point averages, thus show great academic accomplishment and the particular members to be selected will have been trained through the START pre-college program held in late August for both newly entering freshmen and transfer students. Also, the club/organization student officers (President and Vice-President) will accompany the SA START Lead Peer Mentors on a three-day, off-campus *training retreat* annually to prepare for their roles as lead peer mentors (replication of an element of the successful SA program) for this project. The role of the lead peer mentors will be to: 1) lead with the faculty mentor all monthly semester meetings; 2) maintain open, continual communication with the discipline-based club/organization members; 3) lead the consensus for determining the group's service project; 4) attend one monthly meeting with core SA and college leadership of the project for the purpose of ongoing troubleshooting and leadership development over the semester; 5) participate in the required Lead Peer Mentor Retreat Training; and 6) assist in training their own small learning community in how to use the BlackBoard Learn (BBL) community website for their group (PI will ensure training for use of the BBL is incorporated into the Retreat Training and the first monthly meeting of lead peer mentors.

References:

Christe, B. (2013). The Importance of Faculty-Student Connections in STEM Disciplines: A Literature Review. *Journal of STEM Education*. 14, 3.

Edzie, R. and Alahmad, M. (2013). Exploring the factors that motivate female students to enroll and persist in a collegiate STEM degree program. *7th IEEE GCC Conference*. 419-424.

Kendricks, K., Nedunuri, K. and Arment, A. (2013). Minority Student Perceptions of the Impact of Mentoring to Enhance Academic Performance in STEM Disciplines. *Journal of STEM Education*. 14, 2.

Kuh, G. (2008). High Impact Practices: What They Are, Who Has Access to Them, and Why They Matter. AACU, 9-20.

Sanchez, R., Bauer, T., and Paronto, M. (2006). Peer-Mentoring Freshmen: Implications for

Satisfaction, Commitment, and Retention to Graduation. *Academy of Management Learning and Education.* 5, 1, 25-37.

UHD Factbook. (2011-2012). UHD Factbook 2011-12. Retrieved from http://www.uhd.edu/about/irp/documents/factbook/Fact_Book_2011_2012_new.pdf.

Vogt, C. (2008). Faculty as a Critical Juncture in Student Retention and Performance in Engineering Programs. *Journal of Engineering Education*. 97, 1, 27-36.