



2019 HAWAII UNIVERSITY INTERNATIONAL CONFERENCES
SCIENCE, TECHNOLOGY & ENGINEERING, ARTS, MATHEMATICS & EDUCATION JUNE 5 - 7, 2019
HAWAII PRINCE HOTEL WAIKIKI, HONOLULU, HAWAII

A SYSTEM OF ACTIVITY-BASED STEM LEADERSHIP DEVELOPMENT



PARKER, MARY JO
DEPARTMENT OF NATURAL SCIENCES,
SCHOLARS ACADEMY
IN THE COLLEGE OF SCIENCES AND TECHNOLOGY
UNIVERSITY OF HOUSTON-DOWNTOWN
HOUSTON, TEXAS

Dr. Mary Jo Parker
Department of Natural Sciences
Scholars Academy in the College of Sciences and Technology
University of Houston-Downtown
Houston, Texas

A System of Activity-Based STEM Leadership Development

ABSTRACT

University of Houston-Downtown's Scholars Academy utilizes several mechanisms throughout the collegiate careers of science, technology, engineering, and mathematics majors to purposefully, and intentionally, train undergraduates in the development of leadership skills. The belief that leadership is learned works to develop people and work groups encourages a flexible approach for leadership training. This coordinated effort offers a template for others working with undergraduates and embedded leadership development efforts. Focus on two grant-funded leadership development initiatives provides details of the activities undertaken while informing undergraduate attitudes and perceived levels of leadership capacity.

RATIONALE

Why leadership development in the arena of science, technology, engineering, and mathematics (STEM)? Is intellectual and intelligence capacity deemed as necessary elements of leadership? Yes and no (Dalakoura, 2010). Developing STEM leadership capacity has become a mandate from business and industry as well as civic groups requesting increased volunteerism and "giving back" from the university ranks in general and STEM more specifically (Pearce & Conger, 2003;). There is sufficient research indicating undergraduates do increase their own leadership capacity by simply going to college and engaging in the various college processes. Gains in self-efficacy, community engagement, and increased character development seemingly take place as a result of doing the activities college offers, such as joining social or academic organizations, moving into officership of organizations, mobilizing study groups for a particularly difficult course or examination, and participating in leadership opportunities presenting themselves. All these activities seem to raise the academic performance level of the undergraduate as a result of ownership of the issue/problem and investment in the outcome of the group or exam or community service, thereby supporting growth in leader and leadership skills (Ferman & Van Linden, 1999; Komives, Owen, Longersbeam, Mainella, & Osteen, 2005; Dalakoura, 2010). Social and emotional growth of the collegian can be evidenced in the development of character, responsibility and integrity, or trusting what is said and what will happen. A recent study suggest findings that minorities and women or at-risk individuals appear more open to change in terms of leadership and of change in general, suggesting greater adaptability perhaps due to their life circumstances (Dugan & Komives, 2006).

High impact practices often suggest strong connections to student retention and student engagement as well as character development as it connects to leadership development (Kuh, 2008; AACU, 2008; Kuh & Umbach, 2004). Many four-year colleges and universities encourage a common practice of mentored undergraduate research as a student support

mechanism and as a career development opportunity, especially within the sciences (Lopatto, 2007). Several studies offer well-documented findings associated with undergraduates involved in research experiences in under the guidance of laboratory principal investigators or in the classroom setting using a student-centered, problem-based approach. Likewise, studies on the effectiveness of mentored research experiences indicate several important findings, such as: 1) enhancing the entire undergraduate experience and 2) on increasing the substantive interest in entering a career in science through advanced graduate work (Mogk, 1993). Gains in self-confidence and pathways to science careers, especially among first generation, minority, and female undergraduates were documented in several studies by Lopatto (2004, 2007, & 2009) and Hathaway, et.al, 2002).

In the UHD Scholars Academy mentoring, community engagement, and ambassadorship have been used as vehicles to provide developmental leader and leadership activities, thus creating opportunities for change to occur. In most cases undergraduate leaders act as employees based on stipend funding arising from active grant awards. A system of tiered system of demonstrated change activities and roles leads to increased responsibilities thereby allowing upper division undergraduates to emerge with greater leadership skills arising from responsibilities and a program of guidance. The tiered levels of change opportunities and activities describe the changes which can evolve as the individual begins to sense themselves as leaders, especially as they begin to see leadership as a leader capable of influencing processes between individuals and/or a shared interdependence among individuals, groups, and organizations, and relationship surrounding the organizational climate and customs (Day & Harrison, 2007). Such a system of organized activities for change and growth has arisen as a result of funded federal and state grant support to UHD Scholars Academy and as an intentional review of activities common to the SA organization which historically has produced leaders as a consequence of having been in the program (Micari, Gould, & Lainez, 2010).

THE TIERED SYSTEM

Early Start Modeling as a Peer Leader (Modeling Leadership)

The Scholars Academy (SA) uses a system of tiered leadership from which upper division undergraduates are selected for positions where they must guide other peers in a facilitative manner. The initial opportunity to participate in mentoring arises for a program entitled START program, a week-long daily program is offered to incoming freshman and transfers. The program has several pre-determined objectives including building a feeling of cohort, strategically defining for all the standards, opportunities, and guidelines for SA membership, and contextualizing these within the scope of the science, technology, engineering, and mathematics (STEM) disciplines/majors. For the START program generally undergraduates who have participated in the START program previously as freshman or transfers create the pool of candidates from which peer leaders emerge. Daily debriefings with the START program coordinator occur during the entirety of the START week of activities. During the debriefings, peer leaders work with SA administrative leadership and during the START program the peer leaders facilitate the groups, thus influencing peers while also influencing the organization (Day & Harrison, 2007).

In-Class Peer Leadership (Practicing Leadership)

Undergraduates have additional opportunities in activities to facilitate and influence peers within the classroom setting as peer leaders. These leaders selected in-course as peer leaders continue in this facilitative role in the fall/spring semester within a seminar course. Each is supported financially with a modest stipend. Generally, those attending the START program submit applications following their first year of university. This occurs due to the experiences and activities each experienced initially as a participant. In terms of the upper division undergraduate leaders, tremendous growth is captured from their acting as facilitative leaders within the START program. Evidence of leaders ability to adapt, to consult (with program coordinator), to begin to ask good questions moving their team (followers) to new levels of understanding, increasing their consideration of leadership relationships within the organization (Day & Harrison, 2007).

Peer Mentoring Positions of Leadership (Leading the Organization)

Another tier level of greater responsibility and leadership within the organization occurs in the form of selection as a peer mentor for a discipline group. These leaders are upper division undergraduates, so more than mature and capable of guiding others, thus bring greater experience either from leading or from having been led and experiencing from the leadership skills of their own peer mentor. Peer mentors are selected based on nominations from faculty, staff, or self-nomination and once selected must sign a contract indicating their commitment to the position. The peer mentor position is a year-long position with responsibilities ranging two full academic terms and commitment to meeting once a month with their discipline-based group and PhD faculty mentor. Beyond commitment levels, peer mentors must be willing to meet with organizational leadership for in-house training once a month. Prior to selection, those nominated must have demonstrated noticeable nurturance of others (relationship building), character to lead others (integrity and trust), remain facilitative in their responsibilities and actions with their mentees, and demonstrate high commitment to the Scholars Academy organization (organizational climate and culture) as well as to the STEM discipline. These students generally are considered experts in their disciplines. Active grant awards fund the peer mentors' year-long mentoring positions. Finally, all peer mentors participate in an off-campus retreat training for three days and two nights in a camping situation prior to the start of each fall semester. Organization leaders use this time to place all peer mentors, generally urbanites, in a rural environment to create the opportunity for growth and leadership resulting within the new environment. Even at this level of mentorship undergraduates maintain constant communication with the organization leadership to gain advice for situations they may never had experienced, thereby enabling their own growth as a leader.

Senior Peer Mentor Development (Leading the Leaders of the Organization)

The position of senior peer mentor was established early on in the SA organization's interest to empower STEM leaders in leadership associated with organization. Because peer led team learning is a standard training method for almost all undergraduate tutors, the senior peer mentor has generally been trained in this technique, thus seen more as a coach to the other discipline-based peer mentors. The senior peer mentor works directly with the SA administrative personnel

in deciding how and what to present as topics for each monthly meeting. The senior peer mentor facilitates the peer mentors and models high performing leadership qualities. In this way the senior peer mentor influences the future leadership of the organization. Some refer to this process as leadership development in process (Dalakoura, 2010).

Research Leaders Associated with Research Programs (Leading the Organization)

Undergraduates are matched with on-campus UHD PhD research scientists within a variety of STEM lab settings. Leadership develops through this framework, as the PhD comes to understand the qualities/competencies and commitment the undergraduates bring to gaining deep learning of not only discipline content and skills, but also of what research is and what it can become for each of the mentees in the pursuit of individual careers. Early mentored research students are guided by and learn from an upper division undergraduate who has worked with the PhD for some time. As the early career research students develop expertise and competency in the lab and trust on the part of the PhD researcher, they move up within the lab setting and as a leader. Thus, leaders are trained and leadership is developed through this systematic mentorship in research. This particular leadership development tier truly has long-term impact on post-baccalaureate graduate/ professional programs, individual ambitions, and confidence to enter STEM careers (Lopatto, 2004; 2007; Mogk, 1993). Funding support provides those engaged in mentored research, thus bringing a workforce element to this type of leadership development and hopefully, transferability of the skills into the post-baccalaureate workplace.

Community Engagement (Leading the Organization and the Community)

Another opportunity for leader and leadership development occurs through participation in community engagement activities through discipline-based groups. Leadership occurs through our undergraduates providing assistance to others more needy than themselves (even while they are predominantly underrepresented and low socioeconomically disadvantages). Through post-testing surveys lessons learned are gathered and analyzed. While the SA membership may indicate they initially did not want to participate in community service, post-test results indicate strong, uniform understanding of how they are seen as leaders within the community where engagement occurs. Community engagement does not include any type of funding support (Dugan & Komives, 2006). However, in terms of providing opportunity for enhancing intrinsic reward and character development of participating undergraduates, community engagement provides a perfect training ground, one which is low cost and high yield. This is essential as giving back provides an intrinsic reward, character development for each member. Many undergraduates continue to provide community engagement outside of the discipline-based groups, accruing many service hours (approximately 750 per semester or over 1600 per year from discipline-based groups involved in community service. As indicated in some of the post-semester surveys, undergraduates claim the community service makes them 1) well-rounded; 2) gain friendships and soft skills; and 3) experience networking activities. Many speak reflectively of their experiences in these community-based leadership activities such as: 1) pride in self for inspiring children by sharing their story; 2) facing daily struggles together and understanding that together any problem can be fought off; 3) honored to represent their university in such a prestigious light; and 4) actually helping someone.

Outreach Ambassadors (Leading the Organization and its Cultural Climate)

A relatively new opportunity to grow leaders and leadership arose with a Department of Education MSEIP three-year grant valued at \$750,000. Outreach ambassadors were established as another arm of the UHD SA program with goals to recruit for STEM majors primarily and be the face of the SA at external events. The premise of ambassadorship lies in the competence and commitment of the selected undergraduate to the university and the SA program. Ambassadors provide outreach and marketing externally of the university. They become the face and voice of the SA program, thus this is a preeminent position that can be tremendously assistive to recruitment of future undergraduates and strongly communicate the vision, goals, advantages and benefits of the SA program. The ambassadorship requires leadership styles that are telling, selling, and participating as they engage individuals or groups or other organizations in the benefits of the university and the SA program. As is evident, ambassadors are highly competent, highly committed, and highly influential to peers and across the organization. Often, ambassadors may be peer mentors and may have been peer leaders. Active grants support ambassadors, thereby connecting to the organization. Leadership development occurs on a monthly basis and contractual agreements are required of each undergraduate participant. Each must know and be able to communicate the story of the SA program, the opportunities it presents, the requirements, and the historical outcomes that separate this academic unit from others. They must be willing and able to share their own “stories” or accounts of how and why they entered SA, remained with it, and elected to move into a position of leadership by becoming an ambassador.

UHD, SA and Minority Leadership Development

Based on current demographics that Hispanics are likely to become the major ethnic group in Texas by 2030 (Associated Press, 2004) there is a need for Texas to close the science education gap, recruiting more Hispanic students and other minorities into university STEM degree programs. A clear need exists for more minority undergraduate students across a broad natural sciences, computer and mathematical sciences, and engineering technology degree emphasis to enroll in and complete STEM degrees, thus lessening an educational attainment gap evidenced among minorities (Dugan & Komives, 2006). At UHD this includes all degree plans within the College of Sciences and Technology. The ultimate goal of increasing the pipeline of minority students, entering and completing the baccalaureate degree, is related to the need for 1) familiarity of the college experience, 2) pre-college academic support, 3) academic monitoring, 4) mentoring by STEM faculty and undergraduates already successful in the STEM arena, 5) broadened exposure to graduate and industry experts and opportunities, 6) research and career exposure, and 7) leadership development through STEM arenas (DOED MSEIP 2013 award #P120A130040).

Minority students 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 no historical, familial connections to what the collegiate

expectations are for STEM students, thus have less than supportive network available to them once entrance into the STEM degree curriculum begins.

Because UHD is an urban MSI/HSI university located in the 4th largest metropolitan city in the U.S., the tiered leadership development provides an intentional, purposeful vehicle aimed to 1) support minority students seeking university degrees through this large university, 2) examine those leader/leadership tiers influencing STEM undergraduates college to career readiness enhancements, impact, and degree completion (baccalaureate and post-baccalaureate), and 3) create process and product knowledge for other universities, both minority-serving and other, to utilize in the support of education and leadership development positively influencing the changing demographic constituencies and leadership capacity of Houston, Texas, and the U.S.

An brief examination of UHD Scholars Academy senior peer mentors, who were provided both leader and leadership development opportunities in guiding/influencing peers and PhD professor/faculty mentors as well as the SA administration of the organization, encourages a connection between the system of tiered leadership development and influence of career outcomes. Below is a list of each Senior Peer Mentor from inception of the peer mentoring program year three through to the current 18th year of the SA program of leadership development and the growth of leader and leadership as influential on career choices (See Table 1.).

Table 1. Examples of Leadership Influence on Longitudinal Success.

Tier of Leadership	Student Leader	Leader and Leadership Development Influence on Career
Senior Peer Mentor	Diana Leal	Physicians Assistant
Senior Peer Mentor	Iride Gramajo	MS Mathematics
Senior Peer Mentor	Laura Castellanos	Actuarial Workforce
Senior Peer Mentor	Moses Osoro	MD
Senior Peer Mentor	Emily DeLaGarza	Workforce
Senior Peer Mentor	Nicole Patterson	MS Biomedical
Senior Peer Mentor	Audrey Gonzalez	Physicians Assistant
Senior Peer Mentor	Elena Espino	
Senior Peer Mentor	Christine Varghese	MS Epidemiology
Senior Peer Mentor	Brian Holtkamp	PhD (pending)
Senior Peer Mentor	Rebecca Barbosa	Workforce
Senior Peer Mentor	DaNae Woodard	PhD (pending)
Senior Peer Mentor	Westley Wrightson	Engineering Workforce
Senior Peer Mentor	Alice Turchaninova	PhD (application in progress)
Senior Peer Mentor	Glaubyane Viana	Engineering Workforce
Senior Peer Mentor	Takese McKenzie	Undergraduate (Junior)

SUMMARY

Because UHD is an urban MSI/HSI university located in the 4th largest metropolitan city in the U.S., the SA finds leader and leadership development increasingly essential for each undergraduate. More avenues for leadership development continue to be established and all aimed to 1) support minority students seeking university degrees through this large university, 2) assess the pathway of leadership development for women and minorities; 3) create knowledge for other universities, both minority-serving and other, to utilize in the development of their own leadership training programs.

REFERENCES

- AACU. (2008). High Impact Educational Practices. A brief overview. Retrieved at <http://www.aacu.org/leap/hips>.
- Clark, I, Romero-Calderon, R, Olson, JM, Jaworski, L, & Lopatto, D, et al. (2009). “Deconstructing” Scientific Research: A Practical and Scalable Pedagogical Tool to Provide Evidence-Based Science Instruction. *PLoS Biol* 7(12): e1000264. doi:10.1371/journal.pbio.1000264.
- Dalakoura, A. (2010). Differentiating leader and leadership development: A collective framework for leadership development. *Journal of Management Development*, 29, 5, 432-441. Retrieved at <https://doi.org.10.1108/02621711011039204>.
- Day, D. & Harrison, M. (2007). A multilevel, identity-based approach to leadership development. *Human Resource Management Review*, 17, 4, 360-373. Retrieved at www.sciencedirect.com.
- Dugan, J. & Komives, S. (2006). Developing Leadership Capacity in College Students: Findings from a National Study, The Multi-Institutional Study for Leadership –A Project of National Clearinghouse for Leadership Programs. Retrieved from www.nclp.umd.edu.
- Ferman, C. & Van Linden, J. (1999). Character education for developing youth leadership. *Education Digest*, 65, 4, 11-16.

- Hathaway, R.S., Nagda, B.A., & Gregerman, S.R. (2002). The relationship of undergraduate research participation to graduate and professional education pursuit: an empirical study. *Journal of College Student Development*, 43, 614-631.
- Komives, S., Owen, J., Longerbeam, S., Mainella, F., & Osteen, L. (2005). Developing a Leadership Identity: A grounded theory. *Journal of College Student Development*, 6, 593-611.
- Kuh, G. (2008). High-Impact Educational Practices: A Brief Overview. High-Impact Educational Practices: What They Are, Who Has Access to Them, and Why They Matter. *AAC&U*.
- Kuh, G. & Umbach, P. (2004). College and Character: Insights from the National Survey of Student Engagement. *New Directions for Institutional Research*, no 122, Wiley Periodicals, Inc.
- Lopatto, D. (2004). Survey of Undergraduate Research Experiences (SURE): First Findings. *Cell Biology Education*, 3(4), 270–277. <http://doi.org/10.1187/cbe.04-07-0045>.
- Lopatto, D. (2007). Undergraduate Research Experiences Support Science Career Decisions and Active Learning. *Cell Biology Education*, 6(4), 297-306.
doi: 10.1187/cbe.07-06-0039.
- Micari, M., Gould, A., & Lainez, L. (March/April 2010). Becoming a Leader Along the Way: Embedding Leadership Training Into a Large-Scale Peer-Learning Program in the STEM Disciplines. *Journal of College Student Development*, 51,2, 218-230. Retrieved from

DOI: <https://doi.org/10.1353/csd.0.0125>.

David William Mogk (1993) Undergraduate Research Experiences as Preparation for Graduate

Study in Geology. *Journal of Geological Education*: March 1993, Vol. 41, No. 2, pp. 126-

128. <https://doi.org/10.5408/0022-1368-41.2.126>

Pearce, C. & Conger, J. (2003). *Shared Leadership: Reframing the hows and whys of leadership*. Thousand Oaks, CA: Sage.