

Research Experiences and Exploration in Materials Science (REEMS)—A University, Professional Society and Business Partnership Model Promoting Materials Science Education for Houston Community College

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ABSTRACT

In 2015 the West Houston Center for Science & Engineering (WHC), Houston Community College, was awarded funding by the National Science Foundation (DMR) to develop a pilot materials science program, Research Experiences and Exploration in Materials Science (REEMS), focused on introducing materials science to aspiring science & engineering community college students. This multifaceted program provides an opportunity for students from a broad array of interests, backgrounds and ages to gain an appreciation for materials science with respect to their academic and career pursuits. Over the approximately four-year duration of the program, REEMS introduces materials science over the academic year through a voluntary seminar series, and, for a select group of students, participation in summer research experiences at collaborating universities. Academic year activities include conferences with the WHC-REEMS transfer advisor, seminars discussing an overview of materials science, the investigation of the roles of materials science in addressing pressing societal issues, and networking with graduate students, university upper division students, materials research faculty and professionals. This paper will provide an overview of the WHC – REEMS program synergies, impacts and partnership dynamics with participating universities: Rice University, the University of Houston, and the McGovern Medical School at the University of Texas Health Science Center-Houston.

INTRODUCTION

This paper provides background information concerning the important roles that community colleges, in partnership with universities, businesses and professional organizations, serve as sources of recruitment of potential transfer students in the material science fields of study. This overview followed by a discussion of a pilot

materials science educational program underway at the West Houston Center for Science and Engineering, Houston Community College. The discussion will focus on selected synergies, impacts and partnership dynamics.

COMMUNITY COLLEGE BACKGROUND INFORMATION

Recent data [1] from the American Association of Community Colleges notes there are over twelve million community college students across the United States. About 7.2 million of these students are enrolled in degree programs and about 5 million students are enrolled in certificate or terminal associate degree programs. These students attend over 1,100 community colleges, of which 982 are public, 36 classified as tribal, and 90 classified as independent. Females represent about 56% of this student population and males represent about 44%. Blacks and Hispanics represent about 44% of the total student population, White students constitute about 48% and Asian Pacific Islanders and Native Americans combine to represent 7%, with the remainder representing one or more races. Thirty-six percent (36%) of community college students are the first in their families to attend college, 17% are single parents, 4% veterans, 7% are Non-US citizens, and 7% have a prior bachelor's degree. Fifty-one percent (51%) of students are less than 21 years old, 39% range in ages 22-39, with 10% over 40.

When taken as a percentage of the total United States undergraduate student population, community college students represent 41% of all US undergraduates. The nationwide community college population represents 40% of first-time freshmen, 56% of Native Americans, 43% of Blacks, 52% of Hispanics and 40% of Asian/Pacific islanders. These student cohorts, based on diversity in age, demographics, backgrounds and motivation, and maturity level represent a relatively untapped pool of students, many who are seeking direction, advice about professional careers, and the "where-and-how" to obtain the education to move them into productive careers. Transitioning students into materials science, whether by training or obtaining undergraduate and graduate degrees, requires local and regional partnerships among the stakeholders: community colleges, universities, employers, professional organizations, and support from local and regional economic development agencies.

A number of community colleges across the United States have stepped up to that role. Based upon opportunity, need and leadership, a number of established working partnerships among community colleges, universities, business and economic development agencies, have received funding to provide students with structure, direction, degree opportunities, and jobs.

Recent partnerships have provided opportunities in areas including aerospace, biotechnology, energy/electric, engineering, information technology, manufacturing, materials science, and nuclear energy [2-4]. Funding to support these projects and programs has originated across many federal funding agencies, including the National Science Foundation and the Departments of Education, Energy, Homeland Security, and Defence.

The effectiveness and ultimate institutionalization of these programs within the community college and their respective local communities are predicated upon program support and financial commitment from all of the community stakeholders.

PARTNERSHIP DYNAMICS – A PILOT PROJECT TO ESTABLISH A MATERIALS SCIENCE EDUCATIONAL PROGRAM

The West Houston Center for Science and Engineering (WHC) received funding in 2015 to establish a pilot materials science program to provide the opportunity for Houston Community College science and engineering bound transfer students to broaden their academic and career horizons through the study of materials science. The program, *Research Experiences and Exploration in Materials Science (REEMS)*, is funded by the National Science Foundation through the Division of Materials Research, with additional financial support from the Houston Community College District.

The program recruits incoming high school students and returning community college students each spring and summer to participate in a variety of educational, networking, transfer guidance over the academic year and as potential candidates for summer research experiences at partnering universities. The educational activities focus on a series of non-credit seminars that cover the basic introduction to materials, the historical and current impacts of materials on society, and a series of laboratory tours and lectures given by REEMS university research faculty.

HCC students, from across the District are welcome to participate in the academic year activities and bring diverse work experiences and a broad range of interests. Based upon student attendance in the seminars a substantial number of students have yet to select an academic direction and are intrigued by the study and application of materials. Since the fall of 2015, over eighty-one students have participated in the REEMS program academic year activities, and twenty-five students have participated in the summer research experiences. To date, 63% of the students are male and 37% female. Students become interested in materials science based on the interdisciplinary nature of the field and a discovery of how materials have shaped technological advances. University faculty become interested in community college students based upon the diverse nature of the student population and the opportunity to identify and groom talented and motivated students as transfer candidates and future graduate students. Since the first REEMS research experience in 2016, student recruitment is primarily accomplished student-to-student word-of-mouth. Through the continual involvement of REEMS research faculty over the academic year, they have conferred upon the REEMS program a sense of importance and validity as seen by students and their families. REEMS faculty play a significant role in shaping a program that motivates students, in and out of their classrooms and laboratories, and the opportunity to provide guidance, advice and opportunity. The academic and transfer guidance which REEMS students receive over the academic year, at the West Houston Center and through consultation with the REEMS research faculty, plays a significant role in the student determination of where they plan to transfer, **Table II**, and a deliberate decision making process concerning their major field of study, as noted in **Table III**. REEMS staff will be following up with these students in the fall of 2018 to follow up on the REEMS 2016, 2017, and 2018 cohorts regarding their field of study and their progress.

Houston Community College is a designated Hispanic Serving Institution (HIS), with an annual enrollment of 114,000, across the 630 square mile district service area [5]. Females comprise 56% of the student population, and 44% males. Thirty-five (35%) of the student population is classified as Hispanic and 13% as Black students. As shown in **Table I** over 43% of the students participating in REEM activities originate from underrepresented groups. Feedback from most REEMS students indicates that participation in the WHC-REEMS program has reinforced their decisions “to and where to” transfer. This reinforcement is particularly evident in underrepresented groups. A significant push for students to continue their education is a consistent message from each of REEMS research faculty and WHC staff members. One impact noted across each of the REU’s is reflected in that only 23% of students participating in the REEMS program during 2015/2016 and 2016/2017 academic years returned to HCC after the conclusion of the academic year. Many were first year students and continued their

education. Based upon preliminary data, approximately half of these students will eventually transfer to complete their studies. The reinforcement from the WHC staff and REEMS research faculty is having a significant positive influence on students, particularly when students and their parents attend the informal gatherings at the West Houston Center and informational sessions and lab tours at university labs. Interaction of students and parents with REEMS faculty, university administrators, university transfer advisors, and listening to success stories from other HCC students from similar backgrounds, provide the needed catalyst for HCC students and their families to support them as they move forward with their education. Partnership dynamics plays a critical role in linking student attendance at HCC with continuation of their education.

Table I WHC – REEMS Program Student Demographics

WHC-REEMS Demographics	Fall 2015	Fall 2016	Fall 2017	Total
Asian	1	5	7	13
Black	3	9	3	15
Hispanic	6	7	7	20
White	7	20	5	32
Other	0	0	1	1

As students declare their major fields of study, investigation by the REEMS transfer advisor usually uncovers that, on an all too frequent basis, there is a lack of a tangible basis for the choice. As REEMS students consider their educational options, they are asked to talk about why they have chosen their potential fields of study and discuss the pros and cons regarding their chosen transfer university. The opportunity for REEMS students to network with other students, university and HCC advisors and faculty, and materials professionals often begins the process of a definitive assessment of their educational and career ambitions. The WHC REEMS program has found that stability of student's decision regarding transfer appears to be directly correlated with identification of the "why" they have chosen the university and chosen field. About forty to fifty percent of REEMS students have seriously addressed these questions, and often-through conversations with the help of the REEMS university faculty. The introduction of materials science, either as a career or as a degree, has been instrumental in moving this process forward. Over the course of the REEMS program, additional data will be required to move from anecdotal to high levels of confidence in these observations.

Table II WHC REEMS Program Student Transfer

WHC-REEMS STUDENT TRANSFER DATA	Spring 2016	Spring 2017	Spring 2018 (Projected)	Totals
Georgia Tech U	0	0	1	1
Prairie View A&M	0	1	0	1
Return to HCC	12	9	0	19
Rice University	0	2	1	3
Texas A&M	2	13	9	24
Texas Southern U	0	1	0	1
Texas Tech U	0	0	1	1
Univ of Houston	1	8	4	13
Univ of Texas Arlington	1	1	0	2
Univ of Texas Austin	0	0	4	4
Univ of Texas Dallas	0	1	0	1
Univ of Texas HSC - Houston	0	1	1	2
Univ of Texas Tyler	1	6	2	9

Table III WHC-REEMS Program Student Planned Field of Study, Post REU

WHC - REEMS STUDENT FIELD OF STUDY	Spring 2016	Spring 2017	Spring 2018 (Projected)	TOTAL
Biological Sciences	1	2	1	4
Chemistry	0	0	1	1
Computer Science	2	2	1	5
Engineering	11	26	19	56
Mathematics	0	0	1	1
Science	0	3	0	3
Technology	3	1	0	4
Other	0	7	0	7

THE REU

The award from NSF to the WHC is unique in its funding structure and objectives. Generally, funding to support research experiences for undergraduates (REU) is provided directly to research faculty, either as a part of their original award or as a supplemental award, with each faculty member looking to either their university or their contacts with other universities and community colleges to recruit students. The REEMS program reverses this process. Funding is provided directly to the West Houston Center, and it is the Center's responsibility to recruit and prepare students for the REU and serve as the program and financial administrator. Based upon observations over the past decade, this approach has resulted in productive and long-term partnerships between the WHC and collaborating faculty members. The roles of each faculty member are clear: to provide a welcoming and motivational environment, develop research projects that are reasonable with respect to both expectations and student academic background, and allow students to realize their potential.

The demographics and profiles of the REU groups in 2016 and 2017 are similar to the data presented in **Table I**. Of the twenty-five students who have participated in REU's to date, 60% were male, 40% female, 12% Asian, 16% Black, 32% Hispanic, and 40% White. Over eighty percent (80%) of the 2016 and 2017 cohort declared engineering as their major field of study, followed by 12% in biological science and about 2% declaring technology or other. There was an approximate equal distribution of REU students transferring to Prairie View A&M, Texas A&M, UH Central, UT Arlington, UT Dallas, and UT Tyler. The significant outlier in this group is that nine of the 25 REU students returned to HCC the following fall semester. One student in the 2017 REU already had an international master's degree in business administration, participated in the REU to increase his proficiency in computation science and returned to HCC to conclude his course work in physics and math before applying to graduate school. Another student, based upon his research over the 2016 summer, received an internship from the Department of Energy, Oakridge National Labs, to study nanotechnology this fall, and he will be returning to HCC in the spring to conclude his studies and then transfer to UT-Tyler (Houston) to study engineering. Several other students were enrolled in the HCC-Texas A&M Engineering Academy prior to the REU, and are planning to transfer to A&M in the 2018 spring semester. Other students decided to change their majors in the spring of 2016 and returned to HCC to complete course work in either science or engineering. Another student decided to change her major from science to history (to study the history of technology).

At the conclusion of each REU, the WHC sponsors a formal poster session presentation. During these events, invited judges talk with each student about their research and future plans. The poster session has also served as a recruitment tool for enthusiastic REEMS faculty. Two judges, one in 2016 and one in 2017, were impressed with the quality of the REU students and have joined the REEMS faculty group, generating an increase from six to eight research faculty. The 2016 and 2017 REEMS REU poster presentation books are available for viewing at the NSF Advanced Technological Education archive sites and provide student profiles, research abstracts, research posters, and information on each of the REEMS faculty [6-7]. A listing of the recent 2017 REEMS REU project titles is provided as a supplemental document to this paper.

As an observation, it appears that at various times during the summer, students begin to pull together their experiences over the academic year including their course work, various aspects of the materials seminar series, their choice of majors, and transfer university choice. Students realize how much they have learned, have yet to learn, and are learning during a relatively short period. Through this realization process they begin

to identify their achievement potential and a commensurate increase in their self-confidence. This process while overseen by the WHC staff, is significantly enhanced though the interaction of the student with their mentor(s). As demonstrated during the concluding poster session, students respond with confidence, poise, and their optimism about their futures.

CONCLUSIONS

The WHC - REEMS program represents a program whose time, efforts and commitments are distributed among the West Houston Center staff, collaborating institutions, materials professionals, and the REEMS research faculty members. To date, this pilot program has served students well, and as noted in various focus groups, students have developed an appreciation for the rigor, structure and individual attention. Recently, some of these students had an opportunity to be interviewed by an international magazine about the REEMS program [8], and it appears from their comments that our program is on the right path toward expanding student academic and professional career horizons. This paper has provided a preliminary overview of that process and the WHC-REEMS team looks forward to a more in-depth examination upon completion of the program in the spring of 2019. As the WHC REEMS program concludes and the next iteration of the REEMS program is developed, it will be of interest to determine if this pilot program may serve as a model for other community colleges interested in developing partnership based materials programs.

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REFERENCES

1. American Council of Community Colleges: Fact Sheet (2017). Available at: <https://www.aacc.nche.edu/research-trends/fast-facts/> (accessed 16 November 2017)
2. National Science Foundation, Advanced Technology Education Center, ATE Centers. Available at: <https://atecenters.org/et/> (accessed 16 November 2017)
3. National Academy of Engineering; National Research Council. (2012). *Community Colleges in the Evolving STEM Education Landscape: Summary of a Summit*. Washington DC: The National Academies Press.
4. L. Soares, Center for American Progress, Community College Industry Partnerships. Available at: <https://www2.ed.gov/PDFDocs/college-completion/02-community-college-and-industry-partnerships.pdf> (accessed 16 November 2017)
5. Houston Community College Fact Book (2017). Available at: <http://www.hccs.edu/about-hcc/institutional-research/hcc-fact-book/> (accessed 16 November 2017)
6. ATE Central: Archives 2016 REEMS REU Poster Program. Available at: <https://atecentral.net/r33688> ...(accessed 16 November 2017)
7. ATE Central: Archives: 2017 REEMS REU Poster Program Available at: <https://atecentral.net/r33690> ...(accessed 16 November 2017)
8. Research Features: The REEMS Programme: discovering untapped talent Available at: <http://researchfeatures.com/2017/05/15/reems-programme-discovering-untapped-talent/> ...(accessed 16 November 2017)