Final Technical Report

Title: Preparing Underrepresented Minorities for STEM Careers in Energy

Submitted To

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By Isaac Crumbly, PhD- Principal Investigator

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Preparing Underrepresented Minorities for STEM Careers in Energy

The Challenge

America is one of the world's top countries in consuming energy. In 2021, with just 4.25% of the world's population, the U.S. consumed 98 quadrillion British thermal units (Btu) of the world's total 603 quadrillion Btu.[1] With such a high energy demand, the continued success of the U.S. energy industry and other high-tech-based industries are dependent upon an adequate supply of scientists and engineers. The nation's challenge is that most of its population is underrepresented in science, technology, engineering, and mathematics (STEM) disciplines which consist of minorities and women. For example, women, Blacks, Hispanics and American Indians constitute approximately 70% of college students while earning about 45% of undergraduate STEM degrees.[2] In 2021, the Pew Research Center reported that women received only 22% of the bachelor's degrees in engineering and just 19% in Computer Science in 2018.[3] Collectively, Hispanics, Black, American Indian, and Alaska Native people made up 31% of the U.S. population, but only 24% of the STEM workforce in 2021, said the NSF Report.[4] With dwindling energy resources worldwide, the nation must use all segments of its population to maintain its economic advantage and its national security.

Meeting the Challenge

In 1992, the Fort Valley State University (FVSU) Cooperative Developmental Energy Program began to address the challenge of increasing the number and retention of underrepresented minorities (URMs) and women pursuing STEM degrees that are relevant to the energy industry by implementing an innovative dual degree STEM education program with two partnering universities, the University of Nevada at Las-Vegas and the University of Oklahoma. Since 2000, six additional universities have been added to the partnership. In 1993, CDEP implemented a 9th through 12th-grade pre-college STEM pipeline program called the Mathematics, Science, and Engineering Academy (M-SEA).

Synopsis of the Cooperative Developmental Energy Program (CDEP)

The Origin and Objective of CDEP. On July 1, 1983, Fort Valley State University, an Historical Black College and University (HBCU), received start-up funds from the U. S. Department of Energy's Office of Minority Economic Impact (now, Office of Economic Impact and Diversity) to develop and implement an innovative cooperative energy education program that would increase the participation of underrepresented minorities (URM) and women working in the private and governmental sectors of the nation's energy enterprise. As a result of DOE's initial funding, the FVSU-CDEP evolved in two phases. In phase I, CDEP operated as an energy internship program for URMs and female students and lasted from 1983 to 1992. Phase II was placed in operation in 1992 and consisted of implementing dual degree programs with partnering universities in STEM disciplines that are important to the energy industry and other high-tech industries.

The objective of CDEP is to develop a mutually beneficial long-term synergistic relationship between Fort Valley State University and the private and governmental sectors of the nation's energy enterprise in creating a STEM-oriented labor base for URMs and women. This objective is accomplished by (1) providing dual-degree programs out of a combination of disciplines that are important to the energy industry such as engineering, geology, geophysics, health physics, mathematics, biology, and chemistry; (2) forming alliances with major predominately white institutions (PWIs) to implement dual-degree programs in STEM; (3) forming mutually beneficial partnerships with energy corporations, industry, and governmental agencies; and (4) developing a 9th grade through 12th-grade pre-college Mathematics, Science, and Engineering Academy that mentors high school students, introduces them to STEM subjects, and informs them about STEM careers. FVSU-CDEP's current partnering universities consist of Georgia Tech, Grand Valley State University, Penn State University, The University of Alabama, the University of Arkansas, the University of Nevada at Las Vegas, and the University of Texas at Austin (Figure 1). FVSU-CDEP has produced 458 bachelor's STEM degrees. Of the 458 STEM degrees awarded, CDEP's partnering universities have graduated 126 engineers, 51 geoscientists, and 12 health physicists for a total of 189 STEM graduates while FVSU-CDEP has awarded 269 STEM graduates (Figure 1). Approximately 67% of the CDEP students who earned second degrees were in engineering, followed by 27% and 6% of the students earning degrees in geosciences or health physics, respectively.

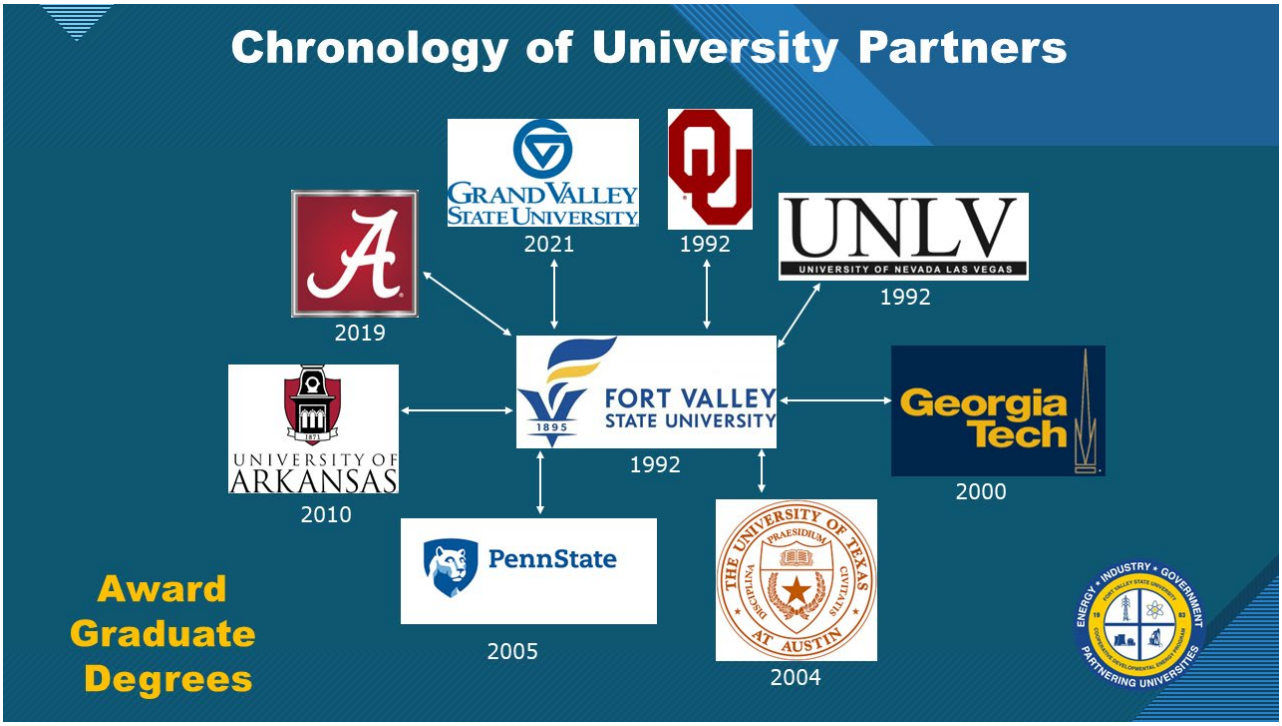

Figure 1: CDEP's partnering universities.

FVSU awards the first degrees in the dual degree partnerships and has graduated 174 mathematicians, 65 chemists, and 30 biologists for a total of 269 graduates (Figure 2). Approximately 65% of the CDEP students who earned the first degree were in mathematics followed by 24% and 11% of the students earning degrees in chemistry and biology, respectively. Students who enter the dual degree program and plan to earn a second degree in engineering are

required to major in math at FVSU except for students who plan to earn a second degree in chemical engineering. Students who have chemical engineering as a second degree have the option of majoring in mathematics or chemistry for the first degree. The strong correlation between the number of engineering degrees earned at partnering universities and the number of mathematics degrees earned at FVSU is exhibited when observing Figure 2.

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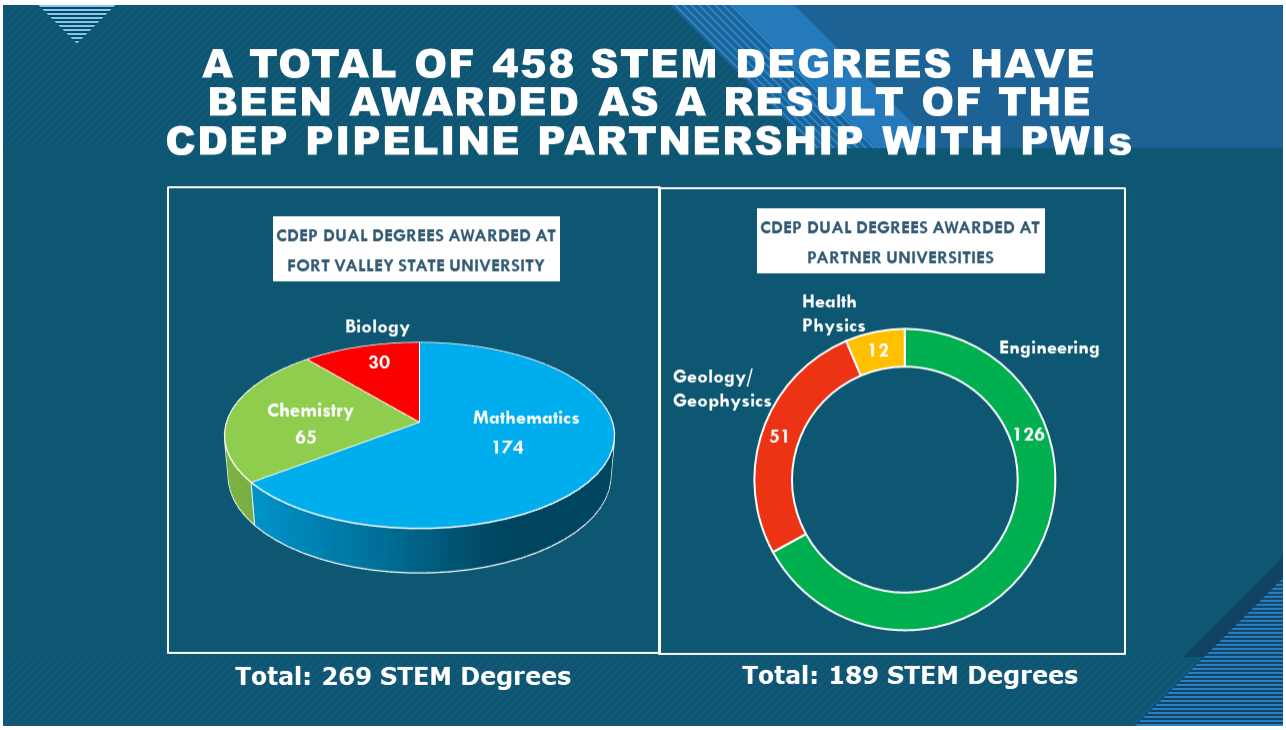

Figure 2: CDEP's STEM graduates from Fort Valley State University

A Diverse STEM Workforce Program for Energy. FVSU-CDEP has been a successful STEM program for the various energy sectors. Figure 3 shows the impact the program's STEM pipeline has had on the oil and gas industry and energy service companies. The pipeline begins in the 9th grade and continues through FVSU and partnering universities. FVSU-CDEP and partnering universities have placed 31 minority and women Engineers, Geoscientists, and Mathematicians in the oil and gas industry. Of the 31 CDEP graduates who have worked in the oil and gas industry, 15 are females or 48.3%. Out of the 20 Geoscientists, 10 are female or 50%. Eleven (11) of the 31 or 35.4% entered the pipeline in the 9th grade which attests to the importance of exposing minority and female students to STEM careers while they are in high school.

Figure 3: CDEP's STEM Graduates - Oil and Gas Companies

Figure 4 gives the quantitative data for CDEP graduates employed by electric and gas utility companies. A total of 18 CDEP graduates have been employed by electric and gas utility companies. Fourteen (14) of the graduates have been employed by the Southern Company and its subsidiary companies or 77.7%. Out of the 18, four (4) are females, or 22.2%.

Figure 4: CDEP's STEM Graduates - Utility Companies

Project Results

On September 7, 2017, the Fort Valley State University Cooperative Developmental Energy Program received funding to support six scholarship students each year enrolled in CDEP's dual degree STEM programs over five years. The five-year request is based on the format of the 3+2 dual degree programs; that is, students spend the first three years at FVSU to earn bachelor's STEM degrees and transfer to one of the seven partnering universities for two years to earn second bachelor's STEM degrees to complete the 3+2 dual degree program. Funding from the grant was used to provide scholarship support for students to matriculate for 3 years at FVSU and two years at one of the partner schools. However, due to the lack of funds stated by DOE's Office of Economic Impact and Diversity, FVSU-CDEP was not funded for the fifth year of the project.

Scholarships awarded cover tuition, housing, meals, and a book stipend for each student. Funding also covered the cost of travel for each student to attend one professional meeting annually, along with travel for the PI and /or a CDEP staff member.

In this project, six students were recruited for the 2017-2020 cohort (Table I) and six additional students were recruited for the 2020-2022 cohort (Table II). Students who failed to maintain his or her GPA of 3.0 or above were replaced by other CDEP students meeting the required GPA. This process is illustrated when student Caitlyn Journey (Table I), who failed to maintain the required GPA at the end of the fall semester of 2017, was replaced by student Raquel Ellis spring semester of 2018. For students to maintain their respective scholarships, they are required to major in Biology, Chemistry, or Mathematics at FVSU and maintain a GPA of 3.0 or above.

First Name	Last Name	Year(s) Funded
Cameron	Brown	Fall 2017-Fall 2020
Diamond	Clay	Fall 2017-Fall 2020
Janna	Muhammad	Fall 2017-Fall 2020
Caitlynn	Journey	Fall 2017 Only
Tyler	Peters	Fall 2017-Fall 2020
Ikeia	Smith	Fall 2017-Fall 2020
Raquel	Ellis	Spring 2018-Spring 2020

Table 1: CDEP's STEM Cohort I - 2017-2020

Table II details students who were in the second cohort. This cohort was funded for only one year, 2020-21.

First Name	Last Name	Year(s) Funded
Dana	Brown	Fall 2020-Spring 2021
Jasmine	Clarke	Fall 2020-Spring 2021
Javier	Guillen	Fall 2020-Spring 2021
Erin	Searcy	Fall 2020-Spring 2021
Colette	Towles	Fall 2020-Spring 2021
Earnest	House	2021 Only

Table 2: CDEP's STEM Cohort II - 2020- 2021

Professional Development

As a part of mentoring students, CDEP encourages students to participate in internships and attend professional meetings. The following represents a list of internships and professional development activities the students in cohort I participated in:

Cameron Brown - Interned with Incorporated Research Institutions for Seismology (IRIS) in Australia. Presented poster presentation at the National Association of Black Geoscientists hosted by the University of Arkansas, Fayetteville Arkansas; presented a poster at the American Geophysical Union, *"Slab Stagnation in Australia and Why Convecting Materials Becomes Trapped in the Mantle"* - San Francisco.

Diamond Clay - Internship "*Effects of Cholesterol on Development and Triglyceride Content of Drosophila"* University of Nevada at Las Vegas- Las Vegas, NV.

Raquel Ellis - "*Marcella Shale Field Course"*, Pennsylvania State University, College Station, PA. *STEM Mentoring Internship: "Mathematics, Science, and Engineering Academy"* with Fort Valley State University Cooperative Developmental Energy Program. Attended National Association of Black Geoscientists conference, University of Arkansas, Fayetteville, AR.

Janna Muhammad - Internship Research Title: *Examining the Competitive Interactions Between Environmental Strains of Pseudomonas Aeruginosa*. Georgia Institute of Technology. Atlanta, GA. Attended National Society of Black Engineers conference in Detroit, MI 2019.

Tyler Peters - Internship at the University of Nevada, Las Vegas. *"Genomic Evolution of Starvation Selected Drosophila"* Las Vegas, NV.

Ikeia Smith - Internship with Mercer University Engineering Research Center. *Provided Relevant Reviews and Aircraft Configuration Base Lining Support.* Warner, Robins, GA

The invasion of the COVID epidemic during the spring of 2020, had a serious impact on internships during the summers of 2020, 2021, and 2022. Many students were not offered in-person internships, which greatly reduced the students' opportunities to conduct research and make presentations at conferences.

CDEP Students' Success at Partner Universities

After each student completed his/her respective degree in Biology, Chemistry, or Mathematics at FVSU, each student transferred fall semester of 2020 to one of CDEP's partnering universities to pursue their second respective degrees in Engineering, Geology, Geophysics, or Health Physics. **Cameron Brown** and **Raquel Ellis** both graduated with honors from FVSU with BS degrees in Chemistry and transferred to Pennsylvania State University to pursue bachelor's degrees in Geology. Both earned bachelor's degrees from Pennsylvania State University in Geology in May of 2022.

Cameron Brown received an NSF Graduate Fellowship in 2022 to pursue a PhD in Geology at the University of California-Los Angeles**.**

Raquel Ellis completed an internship with Chevron Oil Company 2022-2023 and enrolled at the University of Texas-Austin Fall semester 2023 to pursue the MS in Geology**.**

Diamond Clay, after earning the BS in Biology with honors at FVSU**,** transferred to the University of Nevada at Las Vegas and earned the bachelor's degree in health physics in 2022.

Janna Muhammad, after earning the BS in Chemistry with honors at FVSU**,** transferred to the University of Texas-Austin in 2020 and graduated with an MS in Geosciences in 2023.

Tyler Peters, after earning the BS in Mathematics with honors at FVSU**,** transferred to the University of Nevada at Las Vegas in 2020 and graduated with a BS in Computer Engineering in 2022.

Ikeia Smith, after earning the BS in Mathematics with honors at FVSU, transferred to Georgia Institute of Technology to pursue a BS in Engineering and later transferred to another university to continue her educational goals.

Although the students in cohort II only received funding from the grant during the 2020-2021 academic school year, the following is a tracking of their success in the CDEP program:

Dana Brown, after earning a BS degree in Biology with honors at FVSU, transferred to the University of Nevada-Las Vegas in 2022 to pursue a BS in Health Physics. She discontinued her enrollment at the University of Nevada-Las Vegas at the end of fall 2022 semester for stress-related

reasons.

Jasmine Clarke earned the BS in Chemistry with honors at FVSU in 2021 and transferred to the University of Alabama to pursue the MS in Geology. As of September 2023, she has completed all requirements for the MS degree in Geology except the thesis.

Javier Guillen completed the BS in Biology with honors in 2021 and transferred to Grand Valley State University. In 2023, he graduated from Grand Valley State University with an MS degree in Cellular Molecular Biology and delivered the Keynote Commencement speech for his College.

Erin Searcy graduated with a BS in Mathematics with honors at FVSU in 2021 and is pursuing the MS in Engineering at Grand Valley State University.

Colette Towles completed the BS in Mathematics with honors in 2021 at FVSU and enrolled at the University of Nevada-Las Vegas to pursue a Ph.D. in Engineering.

Earnest House graduated in 2023 with a BS in Mathematics with honors from FVSU and is now enrolled at Grand Valley State University pursuing an MS in Engineering.

Assessment and Evaluation

Of the twelve students that graduated from the program, Tables I and II, eight were females and four were males. Only two of 8 females chose Engineering (25%) for the second degree, whereas two of the four males (50%) chose Engineering. Six of the females (75%) chose science STEM fields for their second degree, rather than Engineering. Although the sample number being reported is small, it mirrors data reported by the Pew Research Center in 2018. Women earned 85% of bachelor's STEM degrees in health-related fields, but only 22% of the bachelor's degrees in engineering.[3]

Regarding ethnicity, all students were African American. Eight of the nine females (88.9%) who received scholarship funding graduated with bachelor's STEM degrees from FVSU and enrolled at a partner institution to pursue a second degree. All four of the male students earned bachelor's degrees at FVSU. Eleven out of the twelve students who transferred to second institutions earned a second bachelor's STEM degree and/or pursuing a graduate degree.

Dissemination

The project's PI discussed successes and lessons learned from the project at the *SEG-AAPG : The International Meeting for Applied Geoscience and Energy. 28 August-1 September 2023. Houston, Texas*. The PI made the presentation as a part of a panel. The panel Title: *"Powering the Energy Landscape of Tomorrow: Successful Geoscience Collaboration with Diverse Teams."* The PI plans to continue to gather data and make presentations at national and international conferences.

References

1. Data Source: U.S. Energy Information Administration. October 12, 2023 https://www.eia.gov/tools/faqs/faq.php?id=87&t=1

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3. STEM Jobs See Uneven Progress in Increasing Gender, Racial and Ethnic Diversity. Pew Research Center. P. 5/23. April 1, 2021.

4. Diversity and STEM. Women, Minorities, and Persons with Disabilities 2023. January 30, 2023. P. 5/7. https://new.nsf.gov/news/diversity-and-stem-2023