Meeting the Need for Diversity in STEM Fields

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MESA Community College Program: Meeting the Need for Diversity in STEM Fields

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Abstract:

Despite the large and growing gap in diversity in STEM higher education and employment few studies have described and evaluated individual programs aimed to address the equity gap in STEM higher education, particularly programs aimed specifically at supporting diverse community college students who are pursuing STEM fields. This mixed methods study investigates one such program, The MESA (Math Engineering Science Achievement) Community College Program (MCCP) in six colleges in two states, examining student experiences and outcomes via focus groups, a survey, and statistical data analysis. The study finds that there is at least suggestive evidence that MCCP may produce impressive results in a field of great policy interest. When compared against students who also showed transfer intent in a STEM field MESA students accumulated significantly more college level credits, more STEM credits, and graduated with a transfer degree at significantly higher rates. Students in focus groups attributed program success to the positive and affirming community, academic support, career and professional development activities with diverse mentors, and targeted academic advising they received through MESA, activities that have also been found to be important in previous studies.

Introduction:

Scholars, policymakers and business leaders have pointed to the lack of diversity and equity in STEM fields as a large and growing economic and moral concern. Students and their families are also recognizing that STEM education is an important driver of individual and national economic development. Former President Obama weighed in stating, "We know that many of the high-tech, high-wage jobs of the future are going to be in STEM" (Obama, Barack. December 4, 2014). Despite this concern few studies have described the potential of research-based programs aimed to address the equity gap in STEM higher education, particularly programs aimed specifically at supporting diverse community college students who are pursuing STEM fields. This mixed methods study investigates one such program, The MESA (Math Engineering Science Achievement) Community College Program (MCCP) at six colleges in two

states, examining student experiences via a survey, focus groups, and statistical data analysis. The research explores MCCP influence on student self-efficacy, interest, perception, and persistence in relation to STEM majors and careers.

While none of what follows will come as a surprise to readers, it is worth reviewing the stubborn and troubling gaps in the numbers of underrepresented minorities (URM's) with majors and careers in STEM fields. URM's represent over 40% of K-12 students (National Research Council, 2011; National Academy of Sciences, 2016) and, "Those groups that are the most underrepresented in science and engineering are also the fastest growing in the general population" (National Research Council p. 3, 2011). Despite their large and increasing numbers in the general population, URM's earned just 12.5% of all bachelor's degrees in Engineering in 2011 (National Action Council for Minorities in Engineering, 2012). An even more worrisome fact is that, although African Americans and Latinos are just as likely as white students to enter college with the intention of a STEM major, they are much less likely to graduate with one (National Science Foundation, 2017). Thirty-three percent of white and 42% of Asian American students reporting intent to complete STEM majors and attending a national sample of institutions completed a BA in STEM within 5 years of entering college, compared to only 18% of such African American and 22% of Latino students (HERI, 2010). Not surprisingly, the workforce numbers appear equally bleak. While African-American and Latino workers represent 29% of the U.S. workforce, they account for only 15% of the computing and 12% of the engineering workforces, respectively (Change the Equation, 2013).

To reach larger and more diverse populations of potential STEM students, policymakers, faculty, and political leaders have (at least rhetorically) recognized the value of community colleges in supporting STEM education. "Community colleges are uniquely

positioned to grow the pipeline of STEM professionals and produce more STEM-skilled workers to meet the demand for middle and high skill jobs" (National Governors Association, 2011). Community colleges are able to contribute to reducing the STEM equity gap because of their large size and accessibility. In fall 2014, 42 percent of all undergraduate students in the United States attended community colleges. Of full-time undergraduates, 25 percent attended community colleges (Ma and Baum, 2016). In 2012–2013, 10.1 million undergraduates were enrolled in public two-year colleges (National Center of Education Statistics, 2014, Table 308.10).

Not only are they large in aggregate size, community colleges are also accessible for diverse students who often access them as a first point of entry into the higher education system. Forty-four percent of low-income students (those with family incomes of less than $25,000 per year) attend community colleges as their first college after high school; by comparison, only 15 percent of high-income students enroll in community colleges initially (Ingels et. al, 2014). They also serve more first-generation students; 38 percent of students whose parents did not graduate from college choose community colleges as their first institution, compared with 20 percent of students whose parents graduated from college. They are also more diverse than four-year institutions, 50 percent of Hispanic students start at a community college as do 31 percent of African American students. In comparison, 28 percent of white students begin at community colleges (Ingalls et. al, 2014). In Fall 2014, 56 percent of Hispanic undergraduates were enrolled at community colleges, while 44 percent of black students and 39 percent of white students were at community colleges. (College Board, Trends in Community Colleges, 2016). Nationally, 34% of community college students were URM's in 2008 and the

percentage is substantially higher in some states (Aud, Hussau, Planty, Snyder, Bianco et. al, 2010).

In addition to their success in providing access for diverse students, community colleges have a track record of educating the STEM workforce – 44% of BS or MS grads in STEM fields attended community college at some point (Van Noy and Zeidenberg, 2014). Some community college successes may be attributed to their supportive and welcoming open enrollment policies with small classes, child care, and accessible faculty (Hagedorn & Purnamasari, 2012; Reyes, 2011). Research has demonstrated that STEM students, particularly underrepresented minorities and women, benefit from the additional supports often provided in community colleges (Chang, Sharkness, Hurtado & Newman, 2014; Hurtado, Cabrera, Lin, Arellano & Espinosa, 2009; Cole and Espinosa, 2008). In particular, research has found that, although students' ability and pre-college preparation are important, steady progress through the STEM pipeline also depends on the types of opportunities, experiences, and support students receive while in college (Chang, Eagan, Lin, & Hurtado, 2011; Espinosa, 2011). "The educational experience and the culture of the discipline (as reflected in the attitudes and practices of faculty) make a much greater contribution to [STEM] attrition than the individual inadequacies of students or the appeal of other majors" (Chang, Sharkness, Hurtado, & Newman, 2014).

In addition to the academic and social supports deemed essential for student persistence and transfer, there appear to be some specific recommendations that encourage STEM students in particular to persist, transfer, and ultimately complete a STEM degree. In a quantitative study looking at factors important to STEM student success, Chang, Sharkness, Hurtado, and Newman (2014) found that the negative effects of race were moderated by both

pre-college characteristics and college experiences. In other words, addressing key factors either before students enter college or while they are in college were able to independently and significantly diminish the racial disparities in STEM achievement.

In this and other research these "key factors" include pre-college preparation in the sciences, teacher encouragement, developing intrinsic motivation, and maintaining perseverance (Russel & Atwater, 2005). Also found to be important in previous research are family support, especially for Latino students (Amaya & Cole, 2001; Cole & Espinosa, 2008; Russel & Atwater, 2005), undergraduate research opportunities (Kinkead, 2003; Chang, Sharkness, Hurtado & Newman, 2014), and advising to clarify school or career plans (Hurtado, Cabrera, Lin, Arellano & Espinosa, 2009). Students also appear to persist and transfer when they think of themselves and others (e.g. faculty) recognize them as "science people" (Carlone & Johnson, 2007), and when they consider science as an important part of their self-identity (Chang, et al. 2011; Espinosa, 2011). A welcoming campus racial climate is also important (Hurtado et al. 2007) as is aspiring to attain a graduate degree (Chang et al. 2008). Finally, other researchers have found that elements of social engagement, such as joining a club or participating in science activities (Chang et al. 2008; Chang et al. 2014) and studying frequently with others (Chang et al., 2014) encourage STEM students, and particularly URM and first generation students, to persist and transfer.

While research has identified important factors in facilitating STEM persistence and transfer for diverse populations, few studies have investigated specific programs for efficacy in facilitating underrepresented student success in STEM, and even fewer have investigated such programs at community colleges. Qualitative studies show programs achieving greater STEM student success when student supports such as those detailed in the previous paragraph are

present (i.e. Ong, Wright, Espinosa, Orfield, 2011; Toven-Lindsey, Levis-Fitzgerald, Barber, Hasson, 2015).

One comparative study examined a program for students at UCLA (PEERS) that included academic workshops, counseling, the creation of a supportive community, and exposure to research. The study found that participants earned higher grades in gatekeeper chemistry and math courses, had higher GPA's, completed more science courses, and persisted in science majors at significantly higher rates than a non-participant comparison group (Toven-Lindsey, Levis-Fitzgerald, Barber, Hasson, 2015).

MESA Community College Program (MCCP)

In response to this and earlier research detailing the importance of supports for STEM students, the Math Engineering Science Achievement (MESA) Community College Program (MCCP) was developed. The program now operates in 35 California community colleges, six Washington community colleges, and in many colleges in other states. This research centers on the six MCCP colleges in Washington and two additional colleges in California. The MESA program includes nearly all components that researchers have found to be important for student success. The main program components include:

- **Academic excellence workshops.** Students are scheduled in the same core math and science classes and receive additional formal tutoring sessions from a peer tutor or faculty member through a collaborative approach.
- **Orientation course.** New students receive an advising primer for STEM majors and they learn study and time-management skills to excel as math, science, or engineering majors.
- **Academic advising/counseling.** Students receive individualized academic guidance from a specialized STEM advisor and develop multi-year plans so they can take courses in the most effective sequence and transfer in a timely manner.
- **Student study center.** Each campus provides a dedicated multipurpose space that is the hub for study, workshops, special activities, and information sharing.
- **Assistance in the transfer process.** MESA provides counseling, workshops and visits to four-year universities.

- **Career development.** Students learn specifics about various engineering majors and job experiences. Industry mentors, job shadowing opportunities, career fairs, internships, scholarships, and field trips to companies are also offered.
- **Links with student and professional organizations.** These resources provide mentors, guest speakers and tours of companies.
- **Professional development.** Through workshops and mock job fairs, students learn soft skills, corporate culture, resume writing, and interviewing skills.
- **Industry Advisory partnerships.** Local MESA advisory boards offer valuable connections between students and industry leaders. Corporate representatives, including MESA alumni, participate on boards and provide scholarships, strategic planning, summer internships, field trips, scholarships, employment opportunities, and other resources.
- **Dedicated MESA director.** Participating colleges receive funding to hire a full-time administrative director to coordinate MESA activities or provide significant resources for faculty "buy-out" time. Directors have expertise in STEM coursework and advising and in student development.

Students with STEM interests voluntarily enroll in MESA and must be an underrepresented minority, a woman in science, engineering or math (excluding nursing), and/or a first-generation college student to participate. Students are recruited though word of mouth with other students, by faculty in STEM courses, or by college advisors. Funding for MESA programs is provided by state legislatures, grants, some additional funds are provided by host colleges. To participate, colleges need to commit to providing the core components noted above. In addition to directors on campus, a small statewide coordination office supports programs and coordinates centers and activities in each state.

Initial Research into the MCCP model

The program has shown some impressive success in early evaluations. In Washington, researchers from the State Board for Community and Technical Colleges (WASBCTC) compared MESA students to all STEM graduates in the community college system and found MESA graduates were more diverse (Washington State Board for Community and Technical Colleges, Math Engineering Science Achievement, November, 2016). They were more likely to be first generation college students (47 percent compared to 43 percent), and they were

more likely to be women (30 percent compared to 26 percent). They also compared MESA students with other URM students who did not participate in MESA. The data showed that MESA students were more likely to persist, transfer to a university, and earn a STEM-related bachelor's degree than other under-represented students pursuing STEM studies at participating colleges. WASBCTC also found that 52 percent of students entering the MESA program between 2011 and 2013 went on to earn a two-year degree by 2016 (compared to 20 percent of non-MESA students from all fields with transfer intent). Nearly half earned a STEM associate's degree with many more accumulating significant STEM credit coursework.

Study Research Questions

In an effort to better understand and build on these positive results, the Washington state MESA office housed at the University of Washington designed this study to investigate the influence of MESA Community College Programming on student self-efficacy, interest, perception, and persistence in STEM courses and majors. Three research questions addressed in this study are *Q1: What influences do MESA Community College Program (MCCP) activities have on students' STEM self-efficacy? Q2: How are students' interests and perceptions of STEM influenced by participation in MCCP activities? Q3: What influences do MCCP activities have on students' persistence and completion of degrees?*

Study Methodology

A simultaneous mixed methods approach was taken based on the research questions. The first two research questions are answered by reporting the descriptive statistics from a survey and the findings from qualitative interviews with program administrators and focus groups with students. All of these research activities were conducted by the first author or under her supervision between November 2015 and November 2016. The third research question

is answered through linear and logistic regression analysis of data obtained from the Washington State Board of Community and Technical Colleges wherein MESA students are compared on these outcomes with other STEM transfer intent students in this state system, controlling for student background characteristics.

Colleges represented in this study include every college with a MCCP program in Washington (six colleges) and two additional colleges in California. Colleges were purposefully selected because the principle researcher could verify that the program included each "core component" of the MCCP model described earlier. These colleges have also been awarded consistent and reliable funding by state legislatures to cover core expenses. Finally, programs selected had reached maturity, thereby avoiding the pitfall of documenting implementation challenges rather than programs at full-implementation. Because of data incomparability between the two states due to differences in data collection, variables, and access, we only include the six colleges in Washington in the quantitative data analyses related to research question three.

Survey Methods

Students were asked to "opt-in" to completing a survey. All students in the study population (i.e. 8 colleges total) were emailed the survey, with reminders, and asked to complete it. The survey introduction advised students that it was voluntary and part of a study designed to learn more about their experiences in MCCP and the influence MCCP had on their self-efficacy, persistence, and interest in STEM. Students were explicitly informed the survey was not an evaluation of MCCP. In addition, printed copies of the survey were provided in MESA centers at each college where students congregate. Surveys were anonymous and students could fill them out at their convenience. Students that agreed to participate, completed the short (10 minute)

survey, with most questions answered on a five-point Likert-scale. Students self-identified whether they had more or less than one year of experience in the MESA program. Students with more than one-year's experience were given a slightly longer survey with some additional questions about their frequency of attendance and satisfaction with MESA program components, questions that only students with sufficient time in the "treatment" of MCCP would be able to accurately assess and answer.

The survey included five areas of inquiry, with between three and five questions in each area. It asked students to report on, 1. Future academic and career intentions; 2. Self-efficacy/motivation in STEM courses; 3. Interest in and perception of STEM majors/careers; 3. Level and type of participation in MCCP; 4. Academic preparation in high school; 5. Student demographics.

Surveys were collected through email via a secure survey response system housed at the University of Washington. To boost response rates, paper surveys were also available in MESA centers. The paper and email surveys were combined for analysis. Survey respondents included students at all six colleges in Washington state and the two colleges in California. A total of 155 completed surveys were collected, which represents about 15-20% of the total MESA student population in the eight colleges.

Interview and Focus Group Methods

Data includes the transcripts of in-depth interviews of individual employees at the colleges, and transcripts of focus groups held with MESA Community College Program students at six colleges (two in California and four in Washington) where direct access to students for focus groups was granted. Semi-structured interviews were conducted with six college employees, one in each college, heavily involved in the MESA program of the individual

colleges.

Statistical Data Analysis

To answer research question 3, "What influences do MCCP activities have on students' persistence and completion of degrees?," statistical data was analyzed comparing MCCP participants with students who also showed intent to earn a STEM associate's degree. The data set contains a total of 2,744 transfer intent students in Washington who did not participate in MCCP and an additional 488 Washington MCCP participants.[1] Transfer intent students entered one of the community and technical college system colleges (34 total in the state system) in academic year 2011 and indicated that they intended to earn an academic transfer degree and, in addition, attempted at least one STEM course. MCCP participants also entered a community college in academic year 2011 or 2012 and enrolled in MCCP within that time frame, also indicating that they intended to earn a STEM transfer degree. The data set follows the students through Spring quarter 2016, i.e., for 4-5 academic years, and includes student characteristics as well as three outcome variables, total college level credits earned, total STEM credits earned and whether the student earned a transfer associate's degree by Spring 2016.

Unfortunately, there is no variable or data flag in state or college data to indicate whether a student intends to transfer with a STEM degree or focus or major in STEM, which would be desirable to construct the comparison group for the MCCP students. However, researchers at the Washington State Board for Community and Technical Colleges have developed a list of STEM courses. Enrollment in one of these courses was used as a proxy for STEM intent in the non-MCCP sample. These are courses that appear on worksheets advising students who are intent on earning a STEM transfer degree which courses will satisfy transfer

[1] Comparable data was not available for the California colleges.

requirements, and they include, for example, courses such as Calculus, Organic Chemistry, and Biology for students intending a Biology major. In Washington, transfer courses have been standardized across all community colleges so course names and numbers are equivalent and comparable across all colleges in the system. Students who enter these courses must have passed all developmental math and any other prerequisites to enter the courses, so are a plausible comparison group to the MCCP students.

Three outcomes variables were examined. First, college level credits earned,

Table 1. Descriptive statistics of the three dependent variables

Measure	MCCP Participants n= 488		Transfer Intent Students with a STEM course n= 2744		*Significant at $p<.05$ ** Significant at $p<.01$
	Mean	*SD*	*Mean*	*SD*	
*College Level Credits Earned**	80.68	37.46	77.85	39.24	
*Transfer Associate's Degree Earned***	.57	.50	.40	.49	
*STEM Credits Earned***	35.82	31.87	14.81	19.40	

second, STEM credits earned, and finally, whether or not a transfer associate's degree earned.

Descriptive Statistics

Descriptive statistics with no controls indicate that MCCP students earn significantly more college level credits, significantly more STEM credits, and earn associate's transfer degrees at significantly higher rates than non-participants. In addition, zero-order correlations showed that MCCP students were significantly more likely to be Underrepresented Minorities than non-participants. They were also significantly more likely to be female and older than non-participants

Table 2. Student characteristics correlated with dependent variables

Zero-Order Correlations	1.		2.	3.	4.	5.		6.		7.	
1. MCCP Participants											
2. Age	.32	***		.00	.01	-.03	***	-.04	***	.05	**
3. Sex	.09	***			-.02	.07	***	.04	***	-.08	***
4. URM	.37	***				.01		-.02		.04	*
5. Degree earned	.14	***						.65	***	.19	***
6. College lvl credits	.04	*								.49	***
7. STEM credits	.35	***									

*Significant at p< .05** Significant at p<.01***Significant at p<.001

Zero order correlations also showed that age was negatively associated with college level credits and degree but positively associated with STEM credits, while being a female student was positively associated with earning a degree and with college level credits but negatively associated with STEM credits. In other words, MCCP students had stronger outcomes despite the fact that female gender and greater age in general tend to work against success in STEM.

Multiple linear regression analysis was used for the analysis of factors uniquely associated with college level credits earned, controlling for the variables of age, URM status, and sex. These control variables were entered into the model first: with a zero-order correlation of .07, this block of controls accounted for 1% of the variation in college level credits earned, $F(3, 3213) = 6.60$, $R^2_{adjusted} = .01$, $p<.001$. MCCP participation accounted for significant unique variation in college level credits earned once age, URM status, and sex were controlled for, $R^2_{change}=.01$, $F_{change}16.31$, $p<.001$. For this dataset, the model estimate of the intercept showed that predicted college level credits for male students who did not report URM status and did not participate in MCCP was 85.99 credits, SE=2.98. Being female increased predicted credits by 4.48, all else equal, while, for every additional year in age, predicted credit accumulation drops by .47. Similarly, URM status students would be expected to earn 3.09 fewer credits than non-

URM students. All of these predictors are significantly different from zero, $p<.05$. Again, MCCP membership had a significant and unique positive association with college level credit attainment (b=7.49, SE=1.86, $t(3391)$=4.04, $p<.001$. **Specifically, therefore we find an estimated mean increase of 7.49 college level credits associated with participating in MCCP**, holding all else constant.

The same procedure was repeated for the outcome of STEM credits earned. With a zero-order correlation of .10, the control variables block accounted for 1% of the variation in college level credits earned, $F(3, 3212) = 12.14$, $R^2_{adjusted} = .01$, $p<.001$. MCCP participation accounted for a significant unique variation in STEM credits earned once age, URM status, and sex were controlled, $R^2_{change}=.13$, $F_{change}531.46$, $p<.001$. The model estimate of the intercept predicted STEM credits for male students who did not report URM status and did not participate in MCCP was 24.94 credits, SE=1.81. In contrast to all the previous models for college level credits, being female decreased predicted STEM credits by 5.50, while, for every additional year in age, predicted STEM credit accumulation drops by .34. Similarly, URM status students would be expected to earn 5.32 credits less than non-URM students. All of these predictors are significantly different from zero, $p<.001$. Again, MCCP membership had a significant and unique positive association with STEM credit attainment in the multivariate regression, controlling for these variables (b=25.07, SE=1.09, $t(3212)$=23.05, $p<.001$. **Specifically, there is an estimated mean increase of 25.07 STEM credits associated with participating in MCCP**, holding all else constant.

For the dependent variable of whether a transfer associate's degree was earned multiple logistic regression analysis was again used with hierarchical predictors. Somewhat surprisingly, URM status did not uniquely negatively predict whether a student earned a transfer

associate's degree, although the coefficient was in the typical negative direction, *b* = -.04 (*SE* .08), *Wald*(1) .28, OR = .96. Each year increase in age did uniquely negatively predict whether a student earned a transfer associate's degree, *b* = -.03 (*SE* .01), *Wald*(1) 13.32, *p*<.001, OR = .97. Being a female student significantly positively affected this outcome *b* = .49 (*SE* .07), *Wald*(1) 47.31, *p*<.001, OR = 1.63. MCCP status accounted for significant unique variation in whether the student earned a transfer associate's degree once the three background characteristic variables were controlled, *b* = .78 (*SE* .10), *Wald*(1) 58.47, *p*<.001, OR = 2.19. **The odds ratio indicates that MCCP participants were 2.19 times more likely to graduate with a transfer associate's degree than comparison students who enrolled in a STEM course but who did not participate in MCCP**.

Qualitative Research

With these successful findings in mind, we now turn our attention to the two outstanding research questions relating to the influence of the MESA program on student self-efficacy, interest, and perception in STEM majors and careers. A more basic question of *how* (what change) in students or in campus culture MCCP evokes to positively influence student success rates is at the heart of these questions and critical in developing programs that can mimic positive outcomes. For these questions we report results from a survey and from campus interviews.

Survey Results

Usable survey responses were collected from 155 program participants. As the two community colleges in California were much larger than the Washington colleges, the completed surveys represent about 1/3 students from Urban Community College in California,

about 1/3 from Suburban Community College in California, and about 1/3 from the six Washington community colleges. Researchers looked for differences between the three groups but did not note any significant differences. Reflecting the demographics of the two colleges under study in California, the California colleges did have a greater percentage of Latino students who completed the survey than did the Washington colleges. There were no significant differences in terms of student efficacy, perception, or interest in STEM between the groups (of colleges), or in student interest in transfer to a four-year institution.

All but two students said they were currently participating in MESA and 85% had attended a MESA orientation. Eighty-one percent had taken at least one math class during the 2014-2015 academic year and 80% had taken at least one science course. Ninety percent of students indicated that they were "very interested" in transferring to obtain a bachelor's degree in a STEM field and the remaining 10% were "interested." Forty-six percent of students indicated interest in a science major, an additional 46% indicated a planned engineering or computer science major, and 6% identified math as their intended major.

Five questions were grouped together to create an exploratory composite self-efficacy index. Self-efficacy questions focused on student confidence. Example questions in the scale included: I can solve technically challenging problems; compared with other people in my science and math classes, my study skills are excellent. The average self-efficacy score was a 4.2 on the five-point scale, indicating that students "agree" with the self-efficacy statements. Students with less than one year in MESA had a lower average score of 3.9, possibly indicating that coursework, MESA, and other factors may be playing a role in making the more experienced students more confident as they progress.

Students average score was even higher for the perception and interest scales, with an average score of 4.3 on both scales and no significant difference between students with more versus less time participating in MESA. In MESA programs in K-12 schools one of the expressed goals is to increase student interest in STEM topics. It seems that students in the Community College MESA program are already interested in STEM and join MCCP because of that interest.

Attendance at MESA activities

MESA activities were well attended and highly valued by participants. Ninety-four percent of the responding students had attended at least one Academic Excellence Workshop in the past year, with 41% having attended five or more. Ninety-three percent of respondents had attended at least one career or professional development activity, with 20% attending five or more. Ninety-four percent of students had received advising within the MESA center, with 25% having spoken with a MESA advisor at least five times in the last year. Ninety-four percent of students had used the MESA study center and 51% had used the study center at least five times in the past year. Every student who completed the survey rated their MESA experience as valuable or very valuable, with 82% of students saying he or she "strongly agreed" that being a part of MESA has been a rewarding experience for them.

Student Demographics

The gender balance among the survey respondents was nearly even, 52% were male and 48% female. Reflecting institutions with large Latino populations, particularly at colleges in California, 65% of respondents were Latino/a, 10% were Black/African American, 13% Asian or PI, 4% White/Caucasian, and 8% were "other" or declined to identify. A large majority of students, 77%, said they were the first in their family to attend college.

Prior Academic Experience

Previous studies have found strong academic backgrounds to be a predictor of success for STEM students. This seems to be borne out in these MESA survey respondents. The survey asked about student course taking in high school. Eighty percent of the responding students took chemistry in high school, 42% took physics, 54% took at least pre-calculus math in high school, and 8% participated in a MESA program in high school. Students self-reported their grades – 15% reported mostly A's, 49% reported mostly A's and B's, 21% reported mostly B's, and 16% reported mostly B's and C's in their high school coursework.

Interviews

Interviewees were the primary administrator (the Director) of the MESA Community College Program on six campuses. In most cases these were professional administrative positions, although in one case the Director was also a math faculty member and in another case the Director also taught science courses part-time at the college. In all cases the director had been in their position for at least one year. These interviews were included to verify that all program components were being followed and to learn more about how the director saw the structure and culture of the MESA program before speaking with students. Interviews were also used as a triangulation device and to ensure comparability of program features across campuses visited as well as to ensure a diversity of opinions about program activities and outcomes across the six host colleges. By interviewing program directors researchers were able to get a window into the culture, structure, and challenges in each MCCP program before interacting with students. In many cases the director was able to explain campus-specific nuances, student demographics or program foci that could later be discussed with students in focus groups. For interviews with directors, semi-structured interview protocols were developed

with the purpose to get as much information related to the research questions as possible. While protocols were in place for each participant group, the semi-structured nature of the interview allowed for some flexibility (Merriam, 2009).

Interviews of MESA program administrators focused upon several important topics, such as: 1) To what extent are identified best practices in play at the case study institutions; 2) The organization, delivery, interventions, curriculum, pedagogy, and support services found at each of the study institutions; 3) The policies and practices that administrators believe to be salient to student success.

Student Focus Groups

As a method of qualitative data collection, a focus group is a collective interview on a topic with a group of people who have knowledge of the topic (Krueger, 2008). Participants here included student groups at six institutions (two in California and four in Washington) where direct access to students was granted. A call for student participants was emailed to students by the MESA program director at these campuses and many supplemented this email with additional emails and flyers advertising the opportunity for students. In all cases directors asked for an RSVP but this was often not strictly adhered to by students. For this reason and due to favorable or unfavorable scheduling for students the focus groups varied in size. Researchers attempted to ensure that each student had an opportunity to participate and some focus groups went significantly longer than others in an effort to collect as many student voices as possible.

Table 3. Focus group participation

College	**Number of Participants in focus group**
Washington City College	6
Washington South Suburban College	3
Washington Rural College	10
Washington North Suburban College	11

California Urban College	Focus group #1: 18
	Focus group #2: 9
California Suburban College	16
	73 total students

Students addressed the presence in their campus's MESA program of some of the best practices recommended by authors covered above. Particularly interesting were students' views of what helped or hindered their success in STEM majors and courses. As shown above, seventy-three students are included in the focus group data.

Coding & Analysis

Adhering to the suggestions of Bogdan and Biklen (2007), data analysis began simultaneously with data collection, with both observations and memos generated relating to what may become important "issues raised in the setting and how they related to larger theoretical, methodological, and substantive issues" (p. 165). A constant comparative method of data analysis was employed (Glaser and Strauss, 1967). In this tradition, data analysis begins by identifying segments in the data that are responsive to the research questions (Merriam, 2009). These segments are units of data that are a potential answer or part of an answer to the research questions. Researchers compared one unit of information with the next and looked at recurring regularities in the data that fell into some category, which together seemed to answer a research question. Data collected was analyzed using NVivo qualitative research software, which allows custom coding according to specific themes or categories the researcher is interested in noting.

Several mechanisms were used to achieve high standards of credibility, dependability, and transferability of findings. First, multiple sources of data (interviews among multiple stakeholders, inspection of documents and websites, focus groups) were analyzed to triangulate data relative to participants' claims, and increase the degree of trustworthiness that

the data reflected reality as perceived within the community colleges and program under study (Merriam, 2009).

Second, the principal investigator conducted "member checks" to increase internal validity of data analysis through a process established for respondents to validate the data collected (Merriam, 2009). For example, in follow-up interviews and email correspondence, researchers debriefed findings to verify anything that remained unclear, relative to the study's goals. During each interview and focus group, researchers provided periodic summaries of main points and understandings so as to have a verbal confirmation from the respondent(s) of what was meant or stated where there were questions or doubts regarding meaning making.

Focus group findings

Student focus group participants included 73 students in six colleges (not necessarily the survey respondents). College administration in four colleges in Washington and two colleges in California granted the researchers access to students. The two colleges in California were large campuses with large MESA programs; each program has in excess of 300 total participants. In Washington, programs visited range from about 100 to about 200 participants in MCCP. Colleges are diverse in terms of their size, location (urban, suburban and rural campuses were represented), demographics, and academic focus (while all campuses were transfer-focused some institutions also have large workforce programs). MCCP models also varied somewhat among institutions in terms of recruitment, structure, program philosophy and culture, and program activities. However, all shared core program components and it quickly became apparent that certain themes emerged as perceived to be critical for student success in all programs.

Given high student self-efficacy, interest, and perception in STEM, it is not surprising that students were overall very positive in their comments regarding their experience in MESA. Several themes emerged including 1) the success of the MESA model in building community through academic and social engagement and integration with college courses and activities; 2) the importance of a dedicated and welcoming study space for academic and social support and creation of community; 3) the value of technically and academically competent peer-tutors and workshop facilitators; 4) presence of caring and dedicated staff; 5) the value of career and professional development activities where students can meet and interact with diverse STEM professionals; and, finally, 6) students found important and motivating the "prestige" and "rigor" that MESA provides.

Inclusive social and academic community

One word that was mentioned more than any other and that emerged in nearly every student answer was the success of the MESA model in creating an *inclusive community* for this diverse group of students. A student identifying himself as an underrepresented minority said, "this place brings together people looking to help each other get through courses, people who could use a little more help, it's like an outlet to get information to succeed." Previous studies have also found that joining student clubs and organizations and the creation of community specifically around academic content are important for student success in STEM, particularly for underrepresented minority success (Chang et al 2014).

In fact, the dedicated study space reserved exclusively for MESA students was hailed by students as key to MESA programming and also to their own academic success. Students indicated that, "Support and group study are the most important, this place [the study center] is comfortable and supportive, we are a big family." Campus study centers varied from

small classrooms or large office suites to large open spaces surrounded by smaller rooms that students could reserve. All included computers, printers, white boards, and office supplies. Some also featured couches, coffeemakers, and microwaves, while others were more reminiscent of a classroom.

One campus of the six visited provides an instructive contrast to the rest of the centers. At a large, suburban, and diverse community college in Washington, college administrators saw the benefits of the MESA program and decided to allocate additional funds so that all students interested in STEM (not just the URM and first-generation students MESA traditionally serves) would be able to receive services. They enlarged and opened up the MESA center to all interested STEM students who were dubbed ASEM (Achievement Science Engineering Math) students. However, this well-intentioned program expansion so that any student on campus with a STEM interest could join appears to have diluted the community cohesion felt by the MESA students and lessened program utility and ultimately value for MESA students. The director reported difficulty in getting students to participate in activities and students reported they used the center for tutoring but did not feel the community connection reported at other campuses. It seems the exclusivity of MESA is important – where the safe space of shared community for MESA students can lessen the negative effects of URM and first generation status.

In contrast, students at a large, urban community college in California reported a strong sense of community in their MESA-exclusive space encouraged by welcoming staff with high expectations. Students are required to attend at least four MESA activities each semester. Students described how there were strict requirements to remain in good standing in MESA and felt that the high expectations for program participation encouraged them to get the most out of

their studies and provided a real sense of belonging to a special organization. Many of the students who were newer participants in MESA discussed how they saw the success of students further along in their studies and realized that many successful students were also MESA participants. One student said, "it's like, all the best students in the class – you know the smart kids – are in MESA. So, I thought, hey, maybe that is something I should check out."

Students in the focus groups expressed that, for most of them, the program requirements had encouraged them to take their education more seriously. In all centers visited it was evident that students were gathering for both academic and social reasons. Small groups of students worked around white boards, shared meals and looked over each other's work. One student summed up the study-center as a gathering point, "This place is a community, I made a ton of friends here and the experience takes the huge campus and makes it really tight-knit, it's like we're all suffering together and everyone knows each other." A student at another campus explained why a program aimed at URM and first-generation students was so important, "it's like MESA is inclusive, you know especially for students who have felt excluded in other parts of campus, that really makes it unique, and we are a team." Students relayed that finding a community of likeminded and also diverse individuals was critical to them feeling like "science people," a component previous literature has found important for student success and persistence in STEM coursework (Carlone & Johnson, 2007).

Quality tutoring

Students felt that the professionalized and knowledgeable tutoring staff members made MESA programming and coming to the MESA center especially valuable in helping them pass their courses and grasp course content. In every site visited students indicated they much preferred attending the more formal Academic Excellence Workshops and less formal peer

tutoring sessions or appointments in the MESA center as opposed to receiving tutoring in campus-wide tutoring centers. At one campus, students both laid out the menu of options and agreed, "the general tutoring is awful, the Math Center is hit and miss, the STEM Center is okay but this place [The MESA study center] is definitely the best." Tutors and workshop leaders in MESA centers are selected by the program directors and students felt both had better teaching skills, a more thorough grasp of course material and better training than more general campus tutors. In several of the centers visited tutors were either faculty members or professional staff with degrees in science or math as opposed to peer tutors more common in community college general campus tutoring centers. Many students said that they didn't consider services in general campus settings to be as specialized or helpful as the course help they received in the MESA centers.

A number of students relayed that, while they had a great interest in STEM, they often found themselves placed into developmental math upon entry into the community college. These students found the community at MCCP and help from other students and tutors there were especially important in helping them move through the developmental math sequence and into college level STEM courses. Given the research about the paucity of students who reach college-level math, especially calculus, from developmental sequences, it was surprising to hear from a large number of students in focus groups that they had successfully run the gauntlet of developmental math and were pursuing STEM transfer degrees with the support of MCCP services.

Professional development

Career and professional development opportunities, particularly those with mentoring from diverse professionals, had a large influence on students' motivation and belief in

their ability to achieve a degree. "Leadership retreats with minority speakers are very inspirational, it makes you think that minorities can succeed," said one student. This was a common theme, another student said that success in a STEM field was, "far away land before, an impossible goal, and now I feel it's very much possible, more attainable. I am first gen American, my parents never got a proper education, and education was only for people who could pay. MESA has shown me that because you're poor and first gen doesn't mean you can't succeed." Much of the continued perseverance students displayed was linked to encouragement from MESA staff and other mentors or professionals students had met through MESA events.

Prestige and rigor of program

In addition to the spirit of community and ability to meet diverse professionals who confirmed their career interests and encouraged "grit," students also found a certain "prestige" or "rigor" in the MESA program itself. Since MCCP students were often studying together and doing well in courses, other students saw their success and reported that, prior to joining MESA, they had the impression it was an honors organization. For these students MESA sponsorship of an event or recommendation of a particular course or faculty member was a signal of rigor and quality.

Caring and dedicated staff

This praise for MCCP services as compared to general campus services continued with regard to advising. Students held in high regard the administrative and advising staff they encountered in MESA. One said, "MESA is like a parent looking over you and they talk to you if you aren't doing well. They check up on you." Academic transfer requirements for STEM majors are often complicated and can vary substantially depending on major even within the same discipline or transfer institution. Students found MESA directors and faculty members who

acted as advisors for MESA students to be knowledgeable about student ability and confidence level, academic program requirements at a given targeted transfer institution, specific major requirements, and more nuanced issues, for example, which math faculty member might have a teaching style that a given student might enjoy or want to avoid. This type of "high touch" individual advising is not something students found in more general campus advising centers. Students almost uniformly visited MCCP advisors in lieu of campus advisors. MCCP advisors were also able to offer more personalized services, such as helping with university entrance essays or filling out financial aid forms, services students viewed as critical help.

Institutionalization of the program

Unfortunately, students did not always find out about MESA programs easily or through college channels and the level of institutionalization of the centers and programs varied by campus. Students reported more recruitment happening by peers than by college staff or reported hearing something about MESA but having to seek out more information on their own. There was not widespread information about MESA provided in either campus advising sessions or STEM courses. In colleges where MESA did appear to be more institutionalized a strong director and/or faculty with heavy involvement was key. Scholars have written about the importance of "institutional agents" who advocate and champion for URM students on campus and this seems to be one of the functions of the MESA centers (Dowd, Pak, & Bensimon, 2013; Bensimon & Down, 2012). A director with visibility among students and credibility among other faculty and staff who had a longstanding history at the college was key to program visibility and institutionalization. On campuses with strong such "agents," students reported higher levels of engagement in MESA activities and higher levels of awareness of the MESA program on campus.

In contrast, several programs visited had experienced multiple director changes and resulting programming gaps. In these colleges students reported having to seek out more information about MESA on their own and to do more legwork to participate in activities. Where MESA has been institutionalized in college activities, student numbers, student enthusiasm, and robustness of program improves. A strong director or other faculty member who acts as a MESA "institutional agent" is critical for program success.

Discussion and Limitations

Readers will no doubt have recognized that MCCP students represented in these data are a motivated and self-selected group who have deliberately chosen to participate in a number of ways. Simply deciding to join the MCCP program, much less filling out a survey and/or participating in a focus group are all marks of dedicated and motivated students. However, MESA students do report that, while they had an interest in STEM before MESA and a strong desire to pursue a transfer degree in STEM, MESA has provided them with additional concrete and intangible resources that have allowed them to persist. The mixed methods nature of this study allows for some triangulation of both the qualitative and quantitative research findings. Despite unavoidable issues with selection bias in the comparisons, there is at least suggestive evidence that MCCP may produce impressive results in a field of great policy interest. Even when compared against students who enrolled in a STEM course (i.e. these students have already passed all developmental math and met all prerequisites for the course), MESA students accumulated significantly more college level credits, more STEM credits, and graduated with a transfer degree at significantly higher rates. This is so in spite of MESA students having some characteristics that predict lower success rates.

Conclusion

This research aimed to gather more information about MESA's influence on student self-efficacy, interest, and perceptions regarding STEM majors and careers. Through survey and focus group research, we found that most MCCP students have a fairly high level of interest in and positive perception of STEM before joining MCCP. The program seems to help them understand more fully the nuances in majors and careers and also boosts their understanding of what major coursework and a career in a particular discipline may entail. MCCP students are significantly more likely to be older (a trait negatively associated with positive outcomes for the three outcome variables), female (a trait negatively associated with accumulating STEM credits), and URM (also negatively associated with positive outcomes on the three such variables measured). Despite these challenges, MESA has impressive quantitative outcomes and does seem to provide a boost to student self-efficacy and motivation to remain in a STEM major, and to their ability to accumulate STEM credits and graduate with a transfer degree, often in a STEM field. Students reported that the community they found in MESA was helpful for them in maintaining their interest in STEM studies. Students were, overall, very enthusiastic about MESA and found it an instrumental and essential component in their success as STEM students.

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