An Impact Evaluation of the Bakersfield College's Mathematics Engineering Science Achievement Program Through STEM Education

By

Consuelo Gonzalez-Mosqueda

An Impact Program Evaluation

Presented to the

Faculty of the Department of Public Policy and Administration

School of Business and Public Administration

CALIFORNIA STATE UNIVERSITY, BAKERSFIELD

In Partial Fulfillment of the

Requirements for the Degree of

MASTER OF PUBLIC ADMINISTRATION

May 11, 2018 [Spring Semester]

An Impact Evaluation of the Bakersfield College's Mathematics Engineering Science Achievement Program Through STEM Education

By Consuelo Gonzalez-Mosqueda

This thesis or project has been accepted on behalf of the Department of Business and Public Administration by their supervisory committee:

R. Steven Daniels 5/8/18

R. Steven Daniels, Ph.D. Date

First Reader

Thomas R. Martinez 5/8/18

Thomas R. Martinez, Ph.D. Date

Second

Dedications

I am forever grateful to God that allowed me to go on this educational journey. Thanks to my professors for the helpful guidance with their expertise and critique. I would like to especially thank with all my heart my wonderful MESA students that welcome me in their lives.

Most of all, I would like to say how grateful I am to my supportive husband, Juan C. Mosqueda, my loyal sisters: Rocio, Sandra, and Maria Luisa, my caring brother-in-law Antonio, and both of my parents Consuelo and Jose Luis who I love dearly. I thanked them all for their love, support, and understanding through these academic years**.**

"I am thankful to all those who said No. Because of them, I did it myself." –Einstein

Acknowledgments

This project was made possible with the contribution of the MESA program's staff and Bakersfield College's STEM faculty notably Dr. Cooper for his never-ending support.

Also, a special acknowledgment to my advisors and faculty mentors at CSU, Bakersfield.

As well, an extra special acknowledgment to my classmates "The Dream Team."

"Be the change you want to see in the world"- Gandhi

Table of Contents

Executive Summary

The impact evaluation of the Bakersfield College's (BC) Mathematics Engineering Science Achievement (MESA) program through STEM Education provides broad evidence of the value and role of a Science Technology Engineering and Mathematics (STEM) program. Thus, methods of analysis include theories from economics, sociology, educative evaluation and STEM education research. The impact evaluation in this study utilizes quantitative and qualitative methods.

MESA programs address STEM education and a STEM learning culture from academic activities through teaching, professional development, and lifelong learning. The goal of the BC's MESA program is to improve student persistence, retention, success, course completion, and assist students in transferring competitively into a four-year institution in STEM degrees. The goal is achieved by using a thirteen-component academic model which includes a STEM expert director, student center, counseling services, scholarships, internship experience, mentoring, STEM research, Academic Excellence Workshops (AWEs), and field trips to professional conferences and universities. In all, MESA programs serve over 5,000 students yearly, which indicates a multiplied impact in the state economy including Kern County.

Overall, the evaluation of program impact of BC's MESA program is a necessary process to improve program implementation. The data collected in this study supports the importance of continuing to allocate funds for MESA programs. Based on the results of the study, it is recommended that BC's MESA program model be duplicated in more institutions for the expansion of the benefits and increase STEM graduates in the nation. As well, increased funding will aid and lessened the current STEM professional shortage crisis. Therefore, MESA would assist more students to be competitive in STEM degree completion.

CHAPTER 1

Introduction

The shortage of domestic Science Technology Engineering and Mathematics (STEM) professionals in the United States (U.S.) is a severe issue for global competitiveness that touches state and local education levels. In particular, this issue has directed a wave of public funds into research and programs to create more STEM degree earning professionals. Both federal and state governments have implemented policies and awarded grant funds to continue U.S. competitiveness for innovation in the world economy. One of the fund allocations is at the community college level through the California Community Colleges Chancellor's Office (CCCCO) with the Mathematics Engineering Science Achievement (MESA) community college program grant. The MESA program has impacted many students and communities through STEM education and has focused significant resources on this issue for more than five decades in the state of California. For instance, in the state of California, the MESA program provides academic and student services to increase the number of low-income and underrepresented students who graduate with a STEM degree. Access to MESA program resources is determined through competitive grant competitions. Currently, the Kern Community College District (KCCD), located in the Central Valley of California, is the only recipient of the MESA grant award in the entire Kern County region, situated on the Bakersfield College (BC) campus.

In Kern County, several stakeholders recognize the need for a robust STEM workforce. According to the Kern Economic Development Corporation (2015), Kern County employers, educators, and policymakers have prioritized STEM education (KEDC-Admin, 2015). In essence, there is a general understanding of how important STEM education is to provide skills that are relevant for today's jobs. As stated in the Bakersfield Californian newspaper, local

school districts and industries have invested over 5 million dollars into STEM programs as a response to the demand for highly skilled STEM workers (Foreman, 2015). The MESA program, a key player in this community, addresses the shortage of STEM professionals and in particular focuses on increasing the number of low-income and minority groups to graduate as STEM professionals.

Statement of the Problem

The U.S. Department of Commerce reported in 2011 that STEM jobs had grown three times more than non-STEM occupations from 2000 to 2010. The report estimated an increase in STEM fields of approximately double that of non-STEM occupations between 2008 and 2018 (Foreman, 2015). At the local level, Kern County has low-income and minority communities who need skills in STEM disciplines. As the MESA program targeted populations, these communities represent a vital part of economic growth in Kern County. Thus, to have a thriving economy, these populations must be shuttled to STEM careers. Unfortunately, most college students from this area find STEM education a challenging degree path to follow. Additionally, there are more obstacles that college students face when majoring in STEM fields such as the lack of adequate STEM counseling or professional advising, a lengthy curriculum, family dynamics, economic issues, and the lack of knowledge navigating the higher education system.

Over more than five decades ago, the MESA program began providing an academic model that has impacted and increased student persistence in the STEM disciplines. The program delivers interventions that aid students in overcoming the difficulties and obstacles presented to them during the STEM curriculum. The MESA program serves those who are first-generation students, minority groups and those from low-income backgrounds. The first state legislative allocation of the MESA program was of $250,000 in 1979, conditional upon dollar-

for-dollar matching donations from industry ("Miles Stones in MESA History," 2017). In California, the MESA program has served the community for over twenty-five years assisting to decrease the shortage of STEM professionals in the state. Most recently, MESA has been serving the BC's student population for thirteen years. Currently, MESA's primary objective is to help community college students who are pursuing a STEM degree and come from economic and educationally disadvantaged backgrounds. However, the BC's MESA program services are restricted to a tiny fraction of all eligible students. Current figures show that only one-hundred and twenty-five students can be accommodated due to limited allocation of funds from the state.

A central barrier to adequate funding of MESA is a lack of understanding of critical factors affecting disadvantaged students in STEM education. While BC's MESA program has helped to increase the number of STEM professionals in California, a comprehensive evaluation of the impact of the BC's MESA program has not been conducted. It is crucial to evaluate the MESA program that will clarify effect and support the need for more considerable investment in the MESA program and provide feedback on continuous program improvement.

According to analysts and industry leaders locally and nationally, the demand for highly skilled STEM workers will far outpace the supply (Foreman, 2015). The number of students that have completed a STEM degree has been stagnant making it challenging to fulfill the shortage of STEM professionals. A crucial step to assist the nation's economy is for governmental representatives to reconcile policy and increase funding for programs that impact disadvantaged students through STEM education. Increasing economic investment in Kern County's college students pursuing STEM degrees will aid in alleviating the scarcity of STEM professionals in our nation while ensuring a competitive STEM-skilled workforce.

Purpose of the Study

Research conducted in the U.S. in the past decade has studied efforts to increase STEM college graduates. An investigation conducted by Ronald Ehrenberg (2010) states that the U.S. is behind in competitiveness because of the lack of adequate funding for STEM education and research (Ehrenberg, 2010). In the same manner, Kern County is also behind when it comes to college students pursuing and completing a STEM degree due to poor allocation of funds for programs, such as the MESA program. The purpose of this study is to evaluate the impact of the BC's MESA program through STEM education and to recommend possible policy discussion to increase students earning a STEM degree.

The study will evaluate the impact of BC's MESA program through STEM education by:

- Measuring effects of the MESA academic model and its components relative to STEM retention and degree completion related to educational attainment and economic progress.
- Performing quantitative analysis of MESA students' household income before and after pursuing and completing a STEM degree.
- Applying an ANOVA for comparison of MESA students versus Non-MESA students in STEM fields regarding retention and student success.
- Conducting qualitative analysis on open-ended questions on student perceptions on the value of the MESA program.

The policy discussion recommendations determined after conducting surveys and analyzing existing data will be noted. Thus, the purpose of the paper focuses on researching the impact of BC's MESA program has through STEM education by increasing numbers of STEM professionals from low-income backgrounds and minority groups.

The importance of the study

The demand for STEM professionals in Kern County and the nation is massive, and it requires immediate attention to resolve the problem of scarcity of students earning a STEM degree. Kern County is dependent on oil and agriculture for its economy; therefore, the local economy is affected significantly by the significant fluctuation of employment rates and productivity more than other areas in California. According to Nick Strobel, various "economic development studies for Kern County and the City of Bakersfield have noted the need to attract new types of businesses" which depend on STEM-skilled workers (Strobel, 2017, p.1). Hence, it is imperative to have more STEM professionals from low-income and minority students for diversification and stability of the local and national economy.

It is crucial to recognize that education serves the development of society, state, and economy; therefore, STEM education policy has far-reaching consequences for all citizens (Kiselova & Gravite, 2017). Thus, the study of the impact of BC's MESA program will serve to provide valuable insight on best practice and areas of weakness as it pertains to the efforts towards increasing the number of STEM graduates. Furthermore, the importance of the study relates to a possible recommendation for policies that will address this significant national crisis that requires increasing domestic STEM workers (Ehrenberg, 2010). In summary, understanding the impact of BC's MESA program on STEM education is vital for effective interventions towards assisting students in earning a STEM degree, and inform nationwide efforts to maintain a competitive STEM workforce in the 21st century.

CHAPTER 2

Literature Review

A large body of research has focused on the issues revolving around maintaining a robust pool of STEM professionals in the U.S. The research has coalesced around the conclusion that there is a great need for the nation to increase STEM graduates. This conclusion also affects local economies; according to Strobel, "economic development studies for Kern County and the City of Bakersfield have noted the need to attract new types of businesses to diversify" the economy which includes more STEM-skilled labor (Strobel, 2017, p.1). The need for more local talent earning a STEM degree is indicative of concerns about national security and global economic leadership. This paper investigates the impact of BC's MESA program through STEM education. The study focuses on themes found in the literature, such as filling the gaps through a brokering engagement theory, and a trifecta model that encompasses mentoring, research, and an educational structure. Also, the study emphasizes methodologies of phenomenography, self-efficacy and advising as success indicators in STEM education. The analysis of BC's MESA program impact is focused on the MESA academic model, activities, and the exploration of the effectiveness of such interventions in relation to educational and economic attainment.

The literature shows the need to attract and retain qualified STEM students. Policy-makers agree that there is a lack of STEM professionals in the nation (Piper & Krehbiel, 2015). Currently, the U.S. is at the vanguard of the technological advancements, but this is going to be affected because of the shortage of STEM professionals. According to the National Center for Education Statistics (NCES), fewer than 30% of bachelor's degree seekers entered a STEM field in the U.S. (Chen & Soldner, 2013). The NCES report showcases the problem of the need to increase STEM college graduates who are domestically trained. Furthermore, in the six-year

NCES study period, a total of 48% of students at the bachelor's degree level and 69% of students at associate's degree level who entered STEM fields abandon their STEM studies (Chen & Soldner, 2013). As more jobs depend on some STEM skills, the scarcity of domestic STEM professionals is an issue that will have a significant economic effect. The NCES report indicates that nearly one-half of this exiting declared STEM students had changed their major to a non-STEM field or left the STEM fields by exiting college entirely (Chen & Soldner, 2013). Moreover, STEM programs funded by taxpayer dollars such as MESA that claim to increase the number of STEM graduates must be evaluated.

Initially, the MESA program was established with the intent to increase the number of minority students in STEM-related disciplines (California State Postsecondary Education Commission, 1989). As time passed, the MESA program evolved to provide low-income and underrepresented students with the crucial skills and resources to achieve STEM educational success at the college level. Hence, BC's MESA program has impacted STEM students and STEM professionals in a positive matter by assisting the educational attainment and economic growth of its participants (Miles Stone of MESA, 2017). As a result, the MESA program has impacted BC through STEM education by promoting best practices that empower STEM students to complete their degrees. According to Ehrenberg, appropriate strategies that support persistence in STEM fields will differ across intuitions and pupil types (Ehrenberg, 2010). BC has adopted the implementation of the MESA program's academic model and activities as useful persistence interventions to direct students through the STEM guided pathway. For several years, the CCCCO has collected data on BC's MESA program. This data shows steady retention and success in STEM coursework: higher than 90% on retention courses and 76% in student success as defined by CCCCO (California Community College Chancellor's Office, 2017).

Thus, BC's MESA program has retention and success of its participants as positives outputs that assist in increasing the number of STEM students.

As suggested by research, STEM education improves retention and graduation using a social science brokering engagement theory. At the foundational level, a brokering engagement theory is defined by the partnership of institutional knowledge and resources with those of who are experts in the topic to enrich curriculum, teaching, and learning (McNall, Reed, Brown, and Allen, 2008). The definition comes from social sciences and business but has been applied in STEM research education. In particularly in STEM programs, the brokering engagement model aims to create a level playing field for nontraditional students. The brokering engagement theory model suggests that STEM students need a "middleman" to bridge the knowledge and experience gaps of the student within education which increases persistence among college STEM students (Bouwma-Gearhart, 2014). The MESA program was modeled after a brokering engagement theory that prepares educated and engaged students that strengthen educational and self-value.

The approach by this brokering engagement theory model is to create institutionally-empowered student support staff that can negotiate and navigate the academic landscape on behalf of the student. Hence, BC's MESA program's theoretical model and activities reflect a brokering engagement theory and proper alignment with STEM education, which dramatically impacts the educational achievement of MESA students. The approach of brokering engagement theory used within the MESA program contributes towards bridging the gaps in a STEM learning culture and empowers MESA students. According to an evaluation report of the MESA program in American River College, the MESA program is designed to serve as a bridge between the students who attended a community college and the universities (Lee, And O., & Los Rios Community College District, 1990). Therefore, the MESA program academic model is

designed to close knowledge gaps for students, especially those coming from low-income and underserved populations.

BC's MESA program uses brokering engagement theory with its participants and other methodologies from organizational and business management research that encompasses more than one theoretical framework. Thus, the review of the literature suggests that educational models that involve a trifecta conceptual framework which includes mentoring, research, and an educational structure increase student retention and persistence in the STEM disciplines (Wilson et al., 2012). Currently, BC's MESA program uses a trifecta theoretical model that encompasses research or internship opportunities, mentoring, and a guided academic structure. Substantial research has directed government funding to develop STEM programs that incorporate research, mentoring within education structures to improve STEM student persistence (Wilson et al., 2012). The MESA program offers low-income and underrepresented students the ability to have STEM field experience through research or internships, to have assigned STEM professional mentors, and to have a comprehensive educational plan through a STEM guided pathway.

The literature also suggests that students need a physical environment where they feel welcome and comfortable to increase retention and success. According to Piper and Krehbiel, strategies which include "nurturing environments are strong predictors of student persistence in STEM majors, particularly for women and minorities" (Piper & Krehbiel, 2015, p. 36). The MESA program creates a nurturing environment in a dedicated student center that has a dedicated counselor and director that provides expert advice on STEM education and welcomes students. Studies suggest that, for STEM retention, academic advising is a fundamental process for a student's education in STEM guided career pathway (Sithole et al., 2017). The MESA program conducts intrusive counseling and advising at the student study center. The advice goes

beyond the curriculum to include career, life goals, sharing of responsibility in one-to-one care, and referring students to resources for non-academic issues and co-curricular activities. Additionally, the MESA program's staff recognizes that every student is unique and requires advising that is tailored to the individuals' situations and needs. The program offers an elaborate form of advising shows a caring environment to the individual and increases student retention and success. Hence, the MESA program provides a safe environment by offering a student center with academic and emotional support for students where learning between faculty, and students may occur.

Research also shows that phenomenography, which is defined as a precise applicable model for learning experiences in STEM courses uses the insider knowledge of a tutor or facilitator in the topic to assist students from the students perspective. Phenomenography practices are student-center and approachable in learning using the understanding of the STEM tutors which suggests to increases STEM student persistence (Streitwieser & Light, 2010). Academic Excellence Workshops (AEWs) in the MESA program adopt phenomenography and empower students to course completion. An evaluation conducted on the Hartnell Community College MESA program suggests that students participating in AEWs averaged a full grade increase when compared to match student controls not attending the AEWs (Kane, Beals, Valeau, & Johns, 2004). The AEWs allow students to gain confidence in the subject matters by leading STEM study groups, promote teamwork, and act as facilitators of STEM subjects among peers with the assistance of STEM faculty. Based on the phenomenography methodology, the program participants' perceptions and understanding of STEM course through peers and faculty mentors increase retention and student success (Carlson et al., 2016). Excellently, the MESA program provides the space and environment for a STEM learning culture to thrive. As a result,

the impact evaluation of program would assess interventions like AWEs and a student center in relation to retention, success, educational and economic attainment.

Studies indicate that STEM education is moving from teacher-centered models to student-centered models (Carlson et al., 2016). The BC's MESA program is a student-centered model that seeks to improve STEM education and reduce attrition of low-income and underrepresented students. Accordingly, to reduce attrition and improve graduation rates of STEM students, programs must focus on teaching the students self-efficacy, which is directly related to academic achievement (Dubriwny et al., 2016). Therefore, the input of self-efficacy for a STEM student translates into an output of educational attainment and economic growth. Similarly, the BC's MESA program prepares students to practice self-advocacy through structured educational workshops and student-centered activities. Hence, the assessment of the impact of the MESA program through STEM education should evaluate whether the program increases the persistence of student in the STEM disciplines.

Research also demonstrates that inputs and outputs of academic programs translate to an economic model that recognizes the interrelationships among educational entities, industries and households (Riener & Mayed, 2014). The following themes were noted: filling the gaps through a brokering engagement theory, trifecta theoretical model encompassing mentoring, research and educational structure, proper advising and self-efficacy will be explored in the study to measure the impact of BC's MESA program. Furthermore, impact evaluation also shows that the presence of an academic entity, such as the MESA program increases the levels of educational attainment and factor productivity in the nation (Grammy, 2004). As a result, this paper analyzes the themes concerning the educational and economic progress of STEM students in BC's MESA program and alumni.

Also, the evaluation of the impact of the MESA program will use program theory as an evaluation approach for qualitative analysis for this paper. Hence, the primary point of a program theory is to assist various stakeholders in identifying articulated assumptions, perspectives, interests, attitudes, and values regarding a particular STEM program, such as the MESA program (Greene, DeStefano, Burgon, & Hall, 2006). According to the National Science Foundation, there are three critical issues regarding education evaluation on STEM programs. First, the question must drive the methodology and have robust criteria for evidence relevant to the approach. Second, there is a shortage of well-qualified evaluators for STEM education projects and programs. Third, there is a severe lack of instruments of demonstrated validity and reliability to measure essential outcomes of STEM education interventions (Katzenmeyer & Lawrenz, 2006). Consequently, the methodology used for this paper will be a combination of the theory that comes from educative evaluation, economics, and social sciences.

According to the literature, there is a need to evaluate STEM programs and account the several factors that influence the evaluation designs and data collection methods that would be most appropriate (Wilkerson & Haden, 2014). In this study, the MESA program's components that include the trends noted in the literature review will be measured in relation to educational attainment and economic growth. In all, the impact evaluation will provide evidence that may suggest the need for improvements or recommendations to stakeholders. Primarily, a summative assessment of all the findings will provide information on how well the MESA program has implemented the work plan. Additionally, BC's MESA program summative inputs will be reconciled to the summative measures of educational attainment and economic growth of the STEM workforce to measure the positive impact of the program.

The MESA program's impact results should be considered for comprehensive policy implementation to eliminate the shortage of STEM professionals. It is essential to recognize that STEM education policy, implementation, and evaluation of such policy and programs have considerable consequences for all citizens (Kiselova & Gravite, 2017). As noted in the literature, there is a lack of consistent design, assessment, cost reporting, and outcome evaluation of STEM programs effectiveness (Dillion, Reif, & Thomas, 2016). A complete evaluation of the impact of BC's MESA program will show the value beyond achieving its objectives. According to research, the impact evaluation of STEM programs becomes an indispensable insightful tool for next cycle of program implementation (Wilkerson & Haden, 2014). Therefore, a summative impact evaluation of the BC's MESA program will provide evidence of effectiveness to guide improvement.

The themes noted in the literature of STEM learning and impact research point to recognize that academic completion by STEM majors has to use a holistic approach that involves more than just one theory to have a significant impact through STEM education. Nevertheless, it is critical to engage students in the STEM disciplines by offering cost-effective inputs that are based on student-centered models and concentrate on a learning community in which STEM students will strength self-efficacy and experience learning through others in the STEM fields. Therefore, the impact evaluation of BC's MESA program is essential to policy making, upward mobility, academic achievement and economic advancement of students involved in the program.

Recommendations for programs that conduct impact evaluations bring valuable improvements based on STEM content knowledge (Wilkerson & Haden, 2014). The collected findings on an evaluation offer relevant and feasible recommendations on government STEM

funded programs. Given that BC's demographics reflected a growing student group of special populations in community colleges, the impact evaluation is more relevant to allocate proper funding. Thus, the impact evaluation will allow researchers to gather information from the perspectives of those who have participated in the STEM fields of studies at BC, and the MESA program. In all, the evaluation will correlate to STEM education research theories and methodologies to increase student persistence, retention, and success that lead to socioeconomic growth for underserved communities.

The results the evaluation of BC's MESA program impact will assist stakeholders to create effective policy and resolve the issue of the shortage of STEM professionals in the nation. The MESA program emerged from stakeholders that were concerned about the lack of representation from minority groups in STEM fields (California State Postsecondary Education Commission, 1989). As the demographics change in the nation, the need to evaluate the impact of MESA programs is valuable for the return on investment of taxpayer's dollars. Thus, the comprehensive impact evaluation of BC's MESA program will address the needs of all the stakeholders involved in STEM education.

Overall, a full evaluation based on the brokering engagement theory, a STEM-related trifecta model, STEM intrusive advising, and the teaching of self-efficacy will answer how to increase STEM graduations rates to some extent. It is imperative for stakeholders to go beyond the outcomes of a work plan and seek the impact of the interventions implemented. It is important to know how STEM programs have affected the targeted student populations and the economy. Additionally, the interventions that assist the most marginalized socioeconomic groups in the country should be at the forefront of public policy. The impact evaluation of BC's MESA program will offer insight into the effective implementation of proven theory and

methods that have assisted BC’s STEM students. Therefore, this study hypothesized that the impact evaluation of BC's MESA program increased STEM graduates and contributed to the educational and economic growth of MESA students.

CHAPTER 3

Methodology

Based on the literature review conducted, this study hypothesizes that BC's MESA program has significantly increased the probability of low-income and minority students to obtain or stay within a STEM degree. One set of analysis will focus on the program's critical components that may best explain persistence indicators for students in STEM education. These components of the MESA program are hypothesized to account for the most significant impact in increasing the numbers of students majoring in a STEM discipline. Additional analysis will also look into the social and economic effects of the MESA program on the students that have been involved in the program. All the analyses will attempt to quantify and evaluate the impact of a STEM grant that aims to serve specific student populations.

The methodology in this evaluation uses the impact study practices of CSU, Bakersfield (2004), and Cal Poly SLO (2014) economic impact reports. The assessment will use mixed-method research that includes public data and an online survey. First, the data obtained from a public database, DataMart, generated by the CCCCO will be used to support the evaluation of the BC's MESA program on retention and success of STEM students. The data will be compared to two other groups with comparable characteristics. Additionally, the public data and survey responses obtained will indicate the measurable impact of BC college students' overall student success in STEM courses. Second, the online questionnaire surveys a representative cross-section of current and past BC's MESA and Non-MESA STEM students. The focus of the administered questionnaire will be to collect data on educational and economic attainments.

The online survey will be administered to collect data from both BC's MESA and Non-MESA STEM students who are either current or alumni STEM graduates. Also, online survey

data will be used to validate BC MESA program's components effectiveness. Additional survey questions regarding BC's MESA program's key component will be collected from MESA student and MESA alumni. The evaluation will summarize the information about the impact of BC's MESA program through STEM college education and professional attainment by students involved in the program. Finally, the study will collect data on the contribution that MESA students and alumni that have made within their communities.

The BC's MESA staff and STEM faculty will send out the online survey to BC's STEM, MESA students and alumni using a SurveyMonkey link via email, Facebook, Messenger, LinkedIn, and the Remind application. There will be three sample groups for the impact evaluation of the program. The samples will be from the control groups composed of First-Generation STEM students, and the Educational Opportunity Program Services (EOPS) in STEM fields of studies. Hence, group samples size will be taken from current and former BC's STEM students that have not been enrolled in the BC's MESA program. The third sample size would be from the population that has experienced the BC's MESA program. Furthermore, the sample size for the BC's MESA group will be from an estimated unduplicated count of 937 students from the MESA enrollment lists in the past thirteen years.

Correspondently, the control groups will be compared as Non-MESA students versus BC's MESA program students. Thus, the sample data of the Non-MESA students will be from declared STEM majors selected randomly from a STEM student listserv and sent to STEM students by the MESA staff and BC's faculty. Therefore, the subjects for this survey will be current students and alumni that have attended BC and maintained a STEM major or have obtained a STEM degree.

MESA Evaluation Outline:

I. Public Existing Data

   a. Use retention and student success data available at DataMart by CCCCO
   b. Obtain data on overall retention and success for MESA student and comparable BC's students in STEM disciplines.
   c. Compare both groups to evaluate the effectiveness

II. Online Survey

   a. Information will be gathered about the impact of college education on the professional attainment of BC's STEM student at all college levels.
   b. Measure if the MESA model components contribute to MESA students' degree attainment and economic advancement.
   c. Measure the contribution that MESA alumni have made to their communities.
   d. Measure if students would have completed a STEM degree in the absence of the MESA program.
   e. Measure of the benefits of MESA program assistance in the attainment of the STEM degree.
   f. Measure household income before and after obtaining a degree relating back to the MESA program.
   g. Measure home ownership and value of the home.
   h. Measure MESA program's components effectiveness.

Existing Data Design- Students data on retention and success will be used for the impact evaluation from DataMart, a CCCCO tool, available online for public use. Furthermore, the data available in DataMart is aggregated data specific to BC's student retention and success based on

student discipline of study, and on special population, such as the MESA program. The impact evaluation of BC's MESA program procedure is illustrated in figure 1. The study will measure for MESA student participation in the program's activities that offer mentorship, research, and model education structures by response frequencies. The conclusion of this research study will reveal if BC's MESA program has had a significant impact on students in regards to STEM education and explain possible mechanisms through specific MESA program components.

Survey Design-The online survey design is modeled after the 2004 CSU, Bakersfield's economic study report. Hence, the online survey uses the SurveyMonkey platform for the electronic design with tools that allow high security and privacy for the participants. With regards to content, the online survey contains twenty-eight questions that attempt to measure economic, educational attainment and the effectiveness of the program's components. The online survey has been designed with the expectation that it will take less than ten minutes to complete and has an option for additional comments. Therefore, it will encourage responses and completion of the questionnaire. The online survey SurveyMonkey will be disseminated by the MESA and BC's STEM faculty, and the collector link will be open in a time frame of ten to fifteen days.

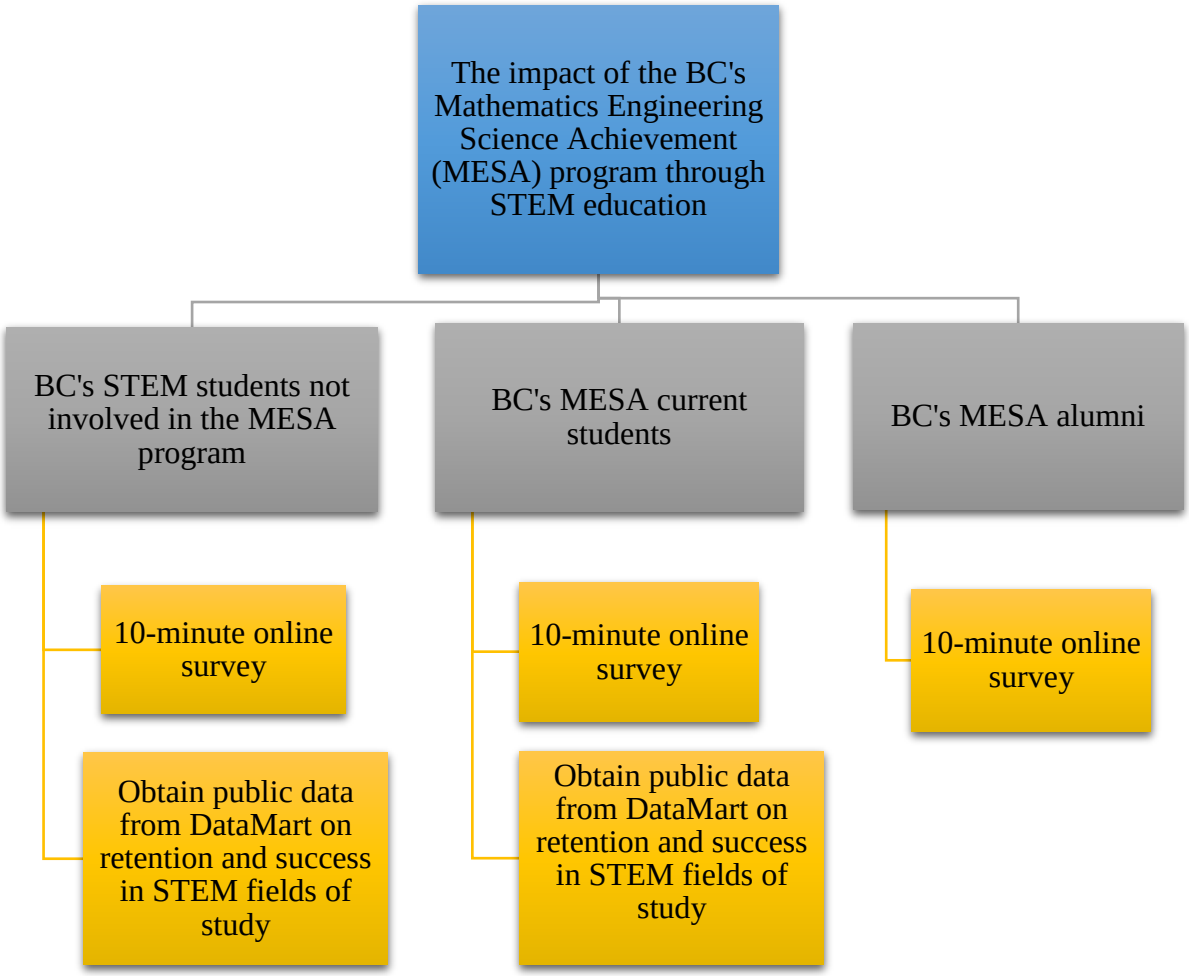


Figure 1. Impact Evaluation of the Bakersfield College's MESA program flowchart.

The central focus of the U.S.'s competitive edge in scientific and technological advancements is to increase the number of college students pursuing STEM degrees. Remarkably, BC's MESA program offers to be part of the solution to the issue. Also, the MESA program has multiple activities with three key set parameters: research or internships experience, mentoring and define institutional structures. The literature suggests that these activities tend to improve STEM education. Therefore, a funded government program, such as the MESA program with proper implementation is part of the solution to the scarcity of domestic STEM professionals as well as to help stabilize the nation's economy.

Ethical Considerations

The study has an approved Institution Research Board Human Subject protocol categorized as a low impact to any human subjects due to the participation of vulnerable populations. The data collected would be kept in the electronic files that it is encrypted by the professional version of SurveyMonkey with no direct student identifier. All participant will complete *Informed Consent* forms that would be retained for at least three years or until the end of the BC's MESA program grant cycle in 2020-2021. Further, the not inclusion IP address tool from SurveyMonkey will also be used to protect the human subjects. Moreover, all data reported on will be carefully handled to protect human subjects involved in the impact evaluation of BC's MESA program. Collected data will be permanently deleted from the SurveyMonkey service by the year 2021. Also, the human subjects use for the impact evaluation of BC's MESA program will be on a volunteer basis.

Additional ethical consideration is the human subject selection criteria that will base on the STEM declared major participants at BC. Accordingly, the student selection will be from students that were enrolled in the MESA program in the past thirteen years and regular STEM students that have not participated in the MESA program. Furthermore, all participants' ages must range from 18 years to 60 years of age.

The MESA program is an academic program that supports and is designed to serve special populations that include ethnic minorities as well as economic and educationally disadvantaged students. Accordingly, the human subjects of this impact program evaluation have to be students directly involved in STEM education. A significant number of the participants will be from an ethnic minority group and low-income students. Consequently, the

need to collect data that will assist programs to help vulnerable population justify the use of the human subjects.

The distributions of the online survey will be assisted by institutional representatives. Although some of the information is public, the responders are not required by law to deliver the desired access to the institution's student STEM and MESA population's contact information, such as e-mails. As reliability is a desired goal, online survey completion will be voluntary and have an option to opt out. For that reason, since the institutions representative have a choice to provide personal student information or to distribute the survey or not, and for this reason, there will not be any ethical problems.

Overall, the study will examine the BC’s MESA program student retention, success, degree completion, and economic advancement as indicators of the positive impact of the program. Accordingly, the research on BC’s MESA program will provide valuable data on MESA students and alumni. All findings will reveal implications for stakeholders and public policy change. Moreover, recommendations for the next grant cycle for BC's MESA program implementation will be developed based on STEM knowledge and updated information. In conclusion, the purpose of this research is to determine if the BC’s MESA program has assisted in increasing STEM graduates coming from minority groups and low-income backgrounds as well as increase economic achievement.

CHAPTER 4

Results and Discussion

Survey instrumentation and data analysis presented in this chapter were used to determine the role of the BC's MESA program on student completion of STEM degrees and the impact on other quantitative outcomes. To adequately address this question, information was collected on differentiated variables student retention, success, STEM-degree holding, income and community engagement. The quantitative analysis was done with the explicit assumption that a variance analysis may efficiently support the role of the MESA program on student retention and success. This role is assumed to impact STEM degree completion and socioeconomic outcomes.

First, an analysis of a multi-semester public data set of special populations was conducted. Identified three data sets extracted from the CCCCO's DataMart were presented in a correlative format with each independent variable tested against the null hypothesis. In this case, data was confounded, and the use of a single factor ANOVA was applied. The sets included First-Generation, Equal Opportunity Program Services (EOPS), and the MESA program. Second, research results of the online survey design to obtain information for the qualitative analysis. The survey was sent out to 937 students involved in the MESA program throughout thirteen years, and Non-MESA STEM students as the control group. Additionally, the administration of the survey design was set to assess the impact of MESA programs' activities qualitatively.

Public Existing Data Results Analysis

The statistical analysis was done using CCCCO's data extracted from DataMart on special populations. The investigation was limited to only include STEM fields of studies for ten semesters. As defined by CCCCO, retention is the number of matriculations with a grade of A,

B, C, D, F, P, NP, I, IPP, INP, and FW after census day. Additionally, the CCCCO defines success as the number count of enrolments with a grade of A, B, C, P, IA, IB, IC, and IPP. The definitions of retention and success defined by the CCCCO were used for the ANOVA. The CCCCO data was extracted from Fall 2012 to Fall 2017 due to the limitation on BC's MESA being available starting Fall 2012.

The results indicated by the summary of ANOVA analysis that BC's MESA program has higher average retention and success than the comparing groups. All groups use as independent variables to measure the impact of each on student retention and success are shown in Table 1. The ANOVA summary reported, First-Generation with an average of 85%, EOPS with an average 89% and MESA with an average of 90% for retention. Also, the ANOVA summary reported an average of 59.8% for First Generation, 63% for EOPS, and 76% for MESA on student success in the STEM fields of studies. All statistical analysis was conducted a normal distribution and no significant duplications in the aggregated data.

Table 1

BC's EOPS and First-Generation students compared to MESA on retention and success

STEM Groups	Retention	Success
First Generation	μ=85.30% , σ = 1.33%	μ=59.80% , σ = 1.93%
EOPS	μ=89.00% , σ = 2.05%	μ=53.09% , σ = 2.84%
MESA	μ=90.73% , σ = 2.05%	μ=76.09% , σ = 2.70%

Note: Caculations conducted assuming normal distribution and no signficant duplication. Data extracted on special population from California Comunity Colleges Chancellor's Office DataMart, 2017.

All identified groups have access to student support services similar to MESA but do not exhibit a brokering of engagement theory or a trifecta program model. The literature suggests

that methodologies such as phenomenography; which is the practice of learning experiences in STEM courses as a learning community increases STEM student persistence (Streitwieser & Light, 2010). The MESA program offers this practice for the MESA students in a study center where they have the opportunity to experience phenomenography and the brokering engagement theory in STEM studies through tutoring and AEWs.

The MESA program's model uses tutor's academic experiences for the AEWs to increase MESA student persistence. Thus, the brokering engagement theory in a learning community increases retention and success in STEM courses. The ANOVA is significant because it reveals an alternative null hypothesis with an F-distribution higher than F-critical. This indicates there is a difference amongst the three groups. Affirmatively, the MESA program has an impact that increases student retention and success.

Public Existing Data Discussion

The data extracted from Datamart on the three identified groups did not have to equivalent sample sizes; therefore, an ANOVA was applied. The results suggest that the MESA program is effective in increasing students that come from low-income and minority groups in STEM education. As a stakeholder, BC has managed to institutionalize a program that has the STEM guided path for underserved populations. The analysis indicates the importance to have a program with an implementation that allows for brokering engagement theory of STEM education in a learning culture. Correspondingly, BC's administration should seek more funds to implement and expand the MESA program for more students pursuing STEM degrees.

Furthermore, the public data analysis implies that CCCCO and public officials in education budgets as stakeholders should seriously consider MESA programs as a solution to the shortage of STEM-skilled professionals. The ANOVA confirms that students involved in the

MESA program performed above the comparison groups in both retention and success. Political representatives collectively with CCCCO must consider increase funding allocations for the existing programs. Furthermore, the ANOVA suggest that BC's MESA program does have an impact on the STEM guided pathways.

Online Survey Analysis

The online survey was 28 questions long, and it was completed an average of 8 minutes via a SurveyMonkey link sent out by MESA staff and BC's STEM faculty via email and disseminated through social media. The sample size for the MESA program was 937 that included current and past students. There were a total 147 survey responses from BC's current and past students which 126 belong to MESA students. Also, the online survey assessed the MESA programs' activities impact on the students. The control sample size was from Non-MESA students in STEM majors from low-income and underrepresented backgrounds, which yield a sample size of 19 respondents.

Both quantitative and qualitative analysis was used to address the question of the role the MESA program has on student completion of STEM degrees and economic attainment. Responses from MESA alumni revealed that 79 degrees in STEM from A.S to Ph.D. were attained. Additionally, 84% of the participants found that the MESA program had assisted them on their degree attainment through STEM education. Furthermore, 39% of responses indicated that MESA program helped them stay or not switch majors to complete a STEM degree. Further, the survey measured which program components and activities students reported had enabled them obtained a STEM education.

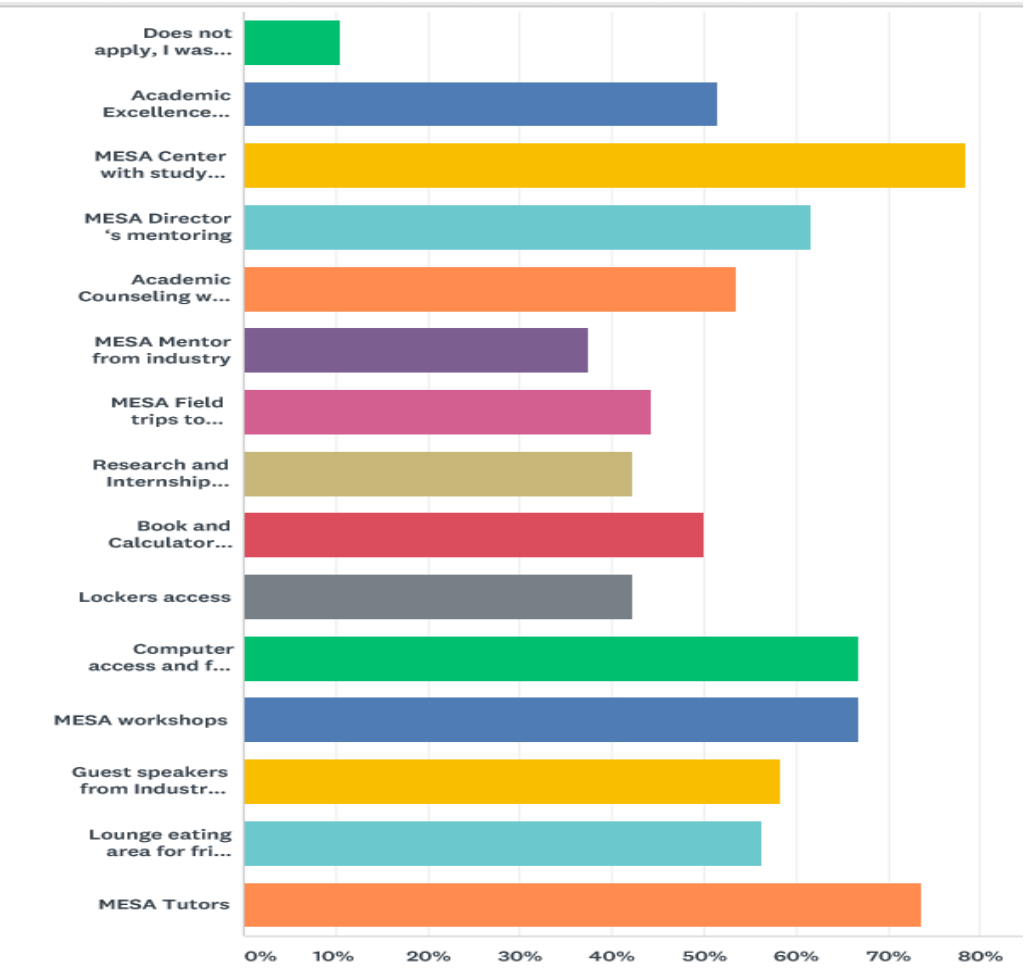


Figure 2. MESA program services, activities, and components that assisted the student to obtain a STEM education**.**

MESA programs activities concerning the theories and methodologies of a brokering engagement theory which suggest that student need someone who knows the subject to direct them to be successful in the particular topics. The top three results in the MESA activities responses support brokering engagement by indicating that need for MESA Tutors, MESA Workshops, and MESA director mentoring. All three MESA activities were conducted by a broker who is an expert on the topic, thus helping the students succeed in the specific subject.

Also, the results indicate the importance of a nurturing environment to thrive in STEM education as suggested by researchers of STEM education (Piper & Krehbiel, 2015). The MESA

program offers the nurturing environment in a welcoming student center which is the most relevant component with a 78% response as to have assisted MESA students in obtaining a STEM education. Also, a 66% responses support that a trifecta model with mentoring, internships or research experience is essential in getting a STEM education. MESA students believed the program helped them to complete their STEM education and continue to transfer into four year-institutions and achieve the Bachelors in Science. The results indicate that the MESA program model does have a positive impact on the student STEM guided pathway.

Responses on economic attainment on MESA and Non-MESA before and after earning a STEM degree were used for quantitating analysis of the survey. A repeated-measures, two-level for pre and post household income with a full factorial was applied. The statistical analysis summary is shown in figure 3. Thus, the results implicated a $20,317 income increase for MESA students. This suggests that a STEM degree completion may lead to economic growth.

Descriptive Statistics

	MESA or Non-Mesa STEM students	Mean	Std. Deviation	N
What is the current household income?	Non-MESA STEM Student	52450.0000	34707.73380	15
	MESA STEM Student	63330.3571	51421.79637	112
	Total	62045.2756	49756.31907	127
What was the household income bracket when you declared your STEM degree?	Non-MESA STEM Student	47666.6667	30356.90476	15
	MESA STEM Student	43012.9464	39955.96548	112
	Total	43562.5984	38872.73291	127

Figure 3. Repeated measurements analysis, two-level on pre and post household income with a full factorial for MESA and Non-MESA students ran in SPSS.

Based on the results it is suggested that educational attainment translates to economic gains MESA students. Additionally, household values were obtained from some of the participants.

Responses to home ownership indicated by respondents had a dollar amount ranging from $225,000 to $499,999, which suggest an economic impact in property taxes. As well, the survey participants were asked if they donated hours or money back the community and over 58% of BC's MESA students and alumni indicated they had done one or both. The qualitative analysis suggests that MESA helps to increase economic gain and impact society and economic growth.

Information gathered on open-ended question revealed that students believed that the MESA program helped and supported the student in STEM fields and their college life as well. Figure 4 shows the word cloud generated by SurveyMonkey's text analysis tool. The size of the word indicates frequency. Thus, the words: tutoring, workshops and mentoring had the most written response at an 18.84%, 17.39% and 15.22% rate, respectively.

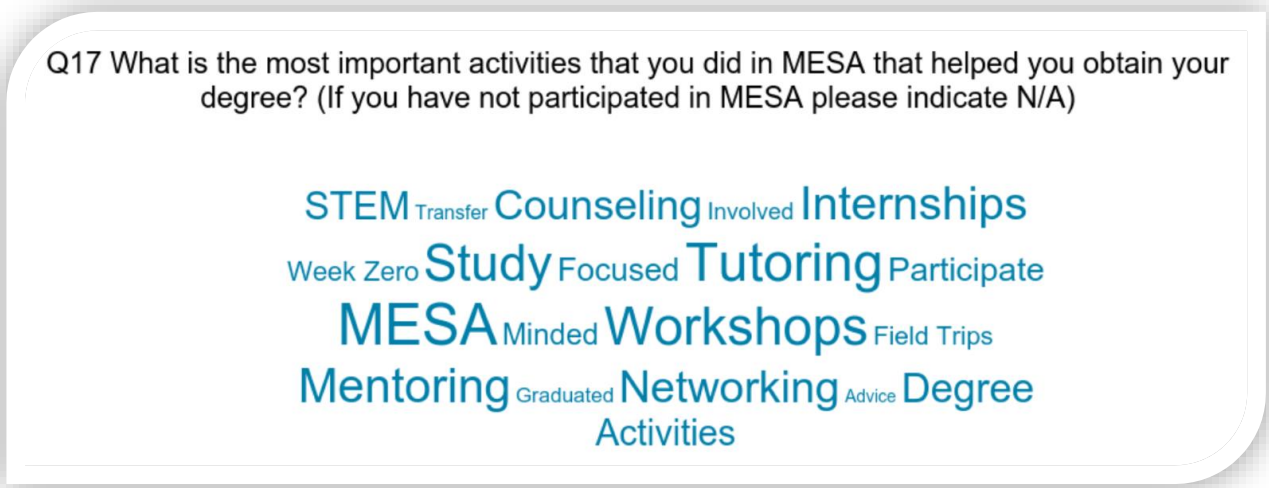


Figure 4. Text analysis word cloud on the online survey for an open-ended question requesting any additional comments.

Discussion of Online Survey Analysis

According to the CSU, Bakersfield study, economic attainment has a significant impact on tax revenue (Grammy, 2004). On the overall BC's MESA program respondents, the online

survey results set the stakeholders to be students, workers, educators, businesses and public representatives. The data collected in the survey indicates that the MESA program has a significant impact on students' STEM education completion and economic attainment.

Since personal income tax provides the most extensive amount to California's general fund, MESA students' economic growth is significant for all the stakeholders that support the MESA programs in general (State Controller's Office, n.d). Tax collected from BC's MESA student and MESA alumni will return to the local economy in the form of public services, such as law enforcement, and fire protection and other public services (Riener & Mayeda, 2014). It is imperative for public representatives and college administrators to recognize the value of BC's MESA programs bring to the community and the economy. Therefore, the implications of supporting programs that implement a trifecta model which allows students to learn and experience a brokering engagement theory, such as MESA for the students in STEM guided pathways are crucial.

CHAPTER 5

Summary and Conclusion

Summary of the study

Understanding the impact of the MESA program is vital to determine grant funding allocations for students seeking a STEM degree. The impact evaluation apprises the MESA program role. The MESA program's role defiantly aligns with the nationwide efforts to maintain a competitive STEM workforce. Hence, the program's impact evaluation was conducted using methodologies and theories from economics, social science, business management, and STEM education research. Accordingly, the study intended to answer if the MESA program had a positive impact on assisting students from low-income and minority groups obtaining a STEM education. Thus, the study suggests the MESA program helped increase the number of STEM degree completions and students economic attainment.

Overall, there were limitations to the evaluation due to the mixed research design and methodology with a time constriction to develop a more comprehensive analysis using the two-phase research. Also, some assumptions were made to use the ANOVA on the study. Moreover, a more substantial number of responses from Non-MESA students would be beneficial to strength any suggestions by the study. As well, to extensively evaluate the impact of the program with a higher confidence level, more responses are required from the 937-sample size of MESA students.

Conclusion

Based on the data extracted from DataMart and online survey analysis, the study suggests that the brokering engagement theory combined with a trifecta model and phenomenography within STEM activities increased retention and student success. The investigation revealed a

90% retention and 76% success for MESA students pursuing a STEM guided pathway, which is higher than the comparison groups seeking a STEM education. Also, the analysis reveals that the program does have an impact on MESA students by the ANOVA applied. Additionally, the impact is suggested by the qualitative analysis of program activities mirroring a trifecta model. The MESA program's model provides workshops, proper educational advising, and a STEM study center, which 84% of MESA students believed have impacted their STEM education.

Suggested by the literature, the use of phenomenography assists students to learn by using the experience of others. The tutors and AEWs facilitators assisted MESA by their own experience in STEM courses. Thus, 78% of the students indicated that tutors helped in the STEM studies. This suggests that retention and success of the MESA students was increase with the use of phenomenography. Altogether, the program increased STEM education persistence for BC'S MESA students. Also, the evaluation established that MESA students have a higher persistence in STEM degrees than Non-MESA students.

The MESA program strengthens the value of STEM education for students that otherwise would have never experienced given their social and economic status. It is important to note that the ANOVA using CCCCO's Datamart was applied to data sets collected from a period that BC had a Hispanic Serving Institution (HIS) STEM grant. Correspondingly, the STEM grant intended to provide an engaging and compelling STEM learning environment for all STEM students, including the control groups use in the study (HIS STEM Abstracts, 2011). Therefore, the findings in this study are more significant for stakeholders.

As the country moves forward in the attempt to increase STEM professionals, the need to evaluate programs beyond the work plan outcomes is crucial. Thus, a statistical analysis of MESA and Non-MESA students' household incomes in regards to degree attainment was

conducted. The analysis was repeated-measures design with two-level full factorial executed using data on pre and post income. The repeated measurements analysis revealed that the household income increases significantly for MESA students. This suggests that educational attainment for MESA student leads to economic growth. Since STEM majors end up in high-income tax brackets; the results indicate the economy benefits in personal and sales taxes from a socioeconomic group that would have typically be at the poverty level.

High-quality STEM education programs represent a chance for students, educators, public representatives and business as stakeholders to preserve the stability of nation's economy. Though, the impact evaluation of the MESA program is critical to increasing STEM professionals coming from low-income and minority groups. As a result, the MESA program's role with a brokering engagement theory in the STEM guided pathway has to be recognized as a solution to issue. Highlighting trends, such as trifecta models, phenomenography and self-efficacy methodologies of learning are essential for STEM education, but the implementation of these must be accompanied by brokering engagement theory.

The brokering engagement theory suggests that a broker must be an expert in the business as well as with the client. In this case, STEM programs that are essential to increase STEM professionals in the nation must have the correct personnel as the brokers of STEM education. Additionally, the interventions offered to students in STEM programs, such as the MESA program must have in a trifecta model that encompasses mentoring, research and an educational structure that leads to self-efficacy. The study confirms that it is imperative to have experienced personnel in STEM education that can relate to student population served by the institution.

Recommendations

Stakeholders and policy-makers should

- Implement MESA using a STEM trifecta model plus a STEM expert that understands the student population.
- Hire and train experienced personnel in STEM education that can relate to student population served.
- Increase MESA program funding beyond the government grants and tap into STEM industry to expand the program to include all STEM students at BC.
- Use the MESA program as a pool of diversity talent acquisition for STEM industry in return for possible funding.
- Expand the BC's MESA model to more colleges to solve the issue of the shortage of STEM graduates in the nation.
- Evaluate STEM program's impact beyond the work plan outcomes.
- Use this evaluation for political and budget advocacy to formally establish policies to implement the MESA program in more institutions.
- Conduct further research on all MESA programs statewide for stronger legislative support.
- Measure positive impact on student and the regional economy more profound, such as to conduct further research on BC MESA program in a longitudinal study of MESA alumni STEM degree attainment and the economic power, intellectual and social capital gained by marginalized socioeconomic groups.
- Research beyond educational and economic attainment to measure persistence in STEM fields by MESA students and assess if not having the MESA program would result in an alternative path of study for the targeted groups.

The MESA program has the policy to assist low-income and minority groups. Accordingly, STEM education to partake and increase STEM professionals must align with effective policy and increase funding. Only then policy for the implementation of STEM funded programs would be updated with proven models that will be more effective to increase persistence and graduation rate of STEM students, primarily from underrepresented groups and low-income students in the country.

References

Bouwma-Gearhart, J., Perry, K. H., & Presley, J. B. (2014). Improving postsecondary STEM education: Strategies for successful interdisciplinary collaborations and brokering engagement with education research and theory. *Journal of College Science Teaching*, *44*(1), 40-47.

California Community Colleges Chancellor's Office, (2017). Retrieved from http://datamart.cccco.edu/Outcomes/Course_Ret_Success_SP.aspx

California State Postsecondary Education Commission, S. (1989). The Effectiveness of the Mathematics, Engineering, Science Achievement (MESA) Program's administrative and policy-making processes. A report to the legislature in response to Assembly Bill 610 (1985). Commission Report 89-4.

California State Postsecondary Education Commission, S. (1989). Evaluation of the Junior MESA Program: A Report to the Legislature in Response to Assembly Bill 610 (Hughes) of 1985. Commission Report 89-30.

Carlson, K., Celotta, D. T., Curran, E., Marcus, M., & Loe, M. (2016). Assessing the impact of a multi-disciplinary peer-led-team learning program on undergraduate STEM education. *Journal of University Teaching and Learning Practice*, *13*(1).

Chen X. & Soldner M. (2013). *STEM attrition: College students' paths into and out of STEM fields*. (NCES 2014-001). Retrieved from http://nces.ed.gov/pubs2014/2014001rev.pdf

Dillion, T.D., Reif, H. R., & Thomas, D. T. (2016) An ROI comparison of initiatives designed to attract diverse student to technology career. *Journal of Information Systems Education*, 27(2), 105-117.

Dubriwny, N., Pritchett, N., Hardesty, M., & Hellman, C. M. (2016). Impact of Fab Lab Tulsa on student self-efficacy toward STEM education. *Journal of STEM Education: Innovations & Research*, *17*(2), 21-25.

Ehrenberg, R. G. (2010). Analyzing the factors that influence persistence rates in STEM field, majors: Introduction to the symposium. *Economics of Education Review*, *29*(6), 888-891. doi:10.1016/j.econedurev.2010.06.012

Grammy A. P., (2004). The economic impact and alumni contribution of California State University, Bakersfield. Retrieved from https://www.csub.edu/kej/_files/CSUBImpact.pdf

Greene, J. C., DeStefano, L., Burgon, H., & Hall, J. (2006). An educative, values-engaged approach to evaluating STEM educational programs. *New Directions for Evaluation*, *2006*(109), 53-71. doi:10.1002/ev.178

Kane, M. A, Beals, C., Valeau, E. J., & Johnson, M.J. (2004) Fostering success among traditionally underrepresented student groups: Hartnell College's approach to implementation of the Math, Engineering, and Science Achievement (MESA) Program. *Community College Journal of Research and Practice*, *28*(10), 17-26.

Katzenmeyer, C., & Lawrenz, F. (2006). National Science Foundation perspectives on the nature of STEM program evaluation. *New Directions for Evaluation*, (109), 7-18. doi:10.1002/ev.175

Kiselova, R., & Gravite, A. (2017). STEM education policies and their impact on the labor market in Latvia, Retrieved from http://files.eric.ed.gov/fulltext/ED574218.pdf

Lee, B. S., And, O., & Los Rios Community College. District, S. R. (1990). MESA/MEP at American River College: Year one evaluation report.

McNall, M., Reed, C.S., Brown, R., et al. (2009). Brokering community-university engagement, *Innovation of High Education*. Retrieved from https://doi.org/10.1007/s10755-008-9086-8

Milestones in MESA History. (2017). Retrieved from https://mesa.ucop.edu/about-us/mesa-history/

Piper, J. K., & Krehbiel, D. (2015). Increasing STEM enrollment using targeted scholarships and an interdisciplinary seminar for first- and second-year college students. *Journal of STEM Education: Innovations & Research*, *16*(4), 36-43.

Riener, K. & Mayeda, P., (2014). The economic impact study of California Polytechnic State University, Retrieved from http://digitalcommons.calpoly.edu/cgi/viewcontent.cgi?article=1001&context=red_rpt

State Controller's Office (n.d). Retrieved from https://www.sco.ca.gov/state_finances_101_state_taxes.html

Sithole A., Chiyaka, E., McCarthy, P., MupingaD. M., Bucklein, B.K., & Kibirige, J. (2017). Retrieved from https://files.eric.ed.gov/fulltext/EJ1126801.pdf

Streitwieser, B., & Light, G. (2010). When undergraduates teach undergraduates: Conceptions of and approaches to teaching in a peer led team learning intervention in the STEM disciplines: Results of a two year study. *International Journal of Teaching and Learning in Higher Education*, *22*(3), 346-356. Retrieved from http://isetl.org/ijtlhe/

Strobel, N. (2017). Why we need a science center? Retrieved from https://www.bakersfieldcollege.edu/sites/bakersfieldcollege.edu/files/why-scicenter.pdf

Wilkerson, S. B. & Haden C. M. (2014). Effective practices for evaluating STEM out-of-school time programs Retrieved from https://files.eric.ed.gov/fulltext/EJ1021960.pdf

Wilson, Z. S., Holmes, L., DeGravelles, K., Sylvain, M. R., Batiste, L., Johnson, M., ... Warner, I. M. (2012). Hierarchical mentoring: A transformative strategy for improving diversity and retention in undergraduate STEM disciplines. *Journal of Science Education and Technology*, *21*(1), 148-156. doi:10.1007/s10956-011-9292-5

Appendix A

Institutional Review Board: Human Subject Protocol Approval Letter

CSU Bakersfield
Academic Affairs
Office of Grants, Research, and Sponsored Programs (GRaSP)

Mail Stop: 24 DDH Room 108
9001 Stockdale Highway
Bakersfield, California 93311-1022
(661) 654-2231
(661) 654-3342 FAX
www.csub.edu

Date: 1 April 2018

To: Consuelo Gonzalez-Mosqueda, Student Investigator, Public Policy Administration
Steven R. Daniels, Faculty Mentor, Public Policy Administration

cc: Roseanna McCleary, IRB Chair

From: Isabel Sumaya, University Research Ethics Review Coordinator

Subject: **Protocol 18-19: Authorization Following Exemption from Full Review**

I am pleased to inform you that your **Protocol "An Evaluation of the Impact of the Bakersfield College's Mathematics Engineering Science Achievement Program Through STEM Education,"** has been approved, following exemption from full review. This research activity was exempted as defined in Paragraph 46.104 (d) (2) of Title 45, Code of Federal Regulations based on the following criteria: (1) Research involving the use of educational tests (cognitive, diagnostic, aptitude, achievement), survey procedures, interview procedures, or observation of public behavior (including visual and auditory), UNLESS : (a) information obtained is recorded in such a manner that human subjects can be identified, directly or through identifiers linked to the subjects, and (b) any disclosure of the human subjects' responses outside the research could reasonably place the subjects at risk of criminal or civil liability or be damaging to the subjects' financial standing, employability, or reputation. Authorization is based on your protocol received on February 22nd, 2018, and again on March 20th, and 29th, 2018, in response to requested revisions.

Use of the Psychology Subject Pool is not authorized.

The PI is responsible for ensuring that all research personnel who participate in data collection and/or obtaining informed consent are HSPT-Certified. The following person[s], only, are authorized to interact with subjects in collecting data, in obtaining informed consent, or interacting with data having personal identifiers.

Human Subjects Protection Training Certified:
Consuelo Gonzalez: CITI-SBE 1/30/2018& R. Steven Daniels: CITI SBE 9/5/2017

This authorization is strictly limited to the specific activities that have been authorized by the IRB. In conducting this research, the investigator must carefully review the final authorized version of the protocol to ensure that the research is conducted as authorized by the IRB. If you want to modify these activities, notify the IRB in advance so proposed changes can be reviewed. If you have any questions, or there are any unanticipated problems or adverse reactions, please contact me immediately.

This authorization will be valid until April 1st, 2019.

California State University, Bakersfield: FWA00013908
Human Subjects Institutional Review Board

Continued on Page 2

CSU Bakersfield
Academic Affairs
Office of Grants, Research, and Sponsored Programs (GRaSP)

Mail Stop: 24 DDH Room 108
9001 Stockdale Highway
Bakersfield, California 93311-1022

(661) 654-2231
(661) 654-3342 FAX
www.csub.edu

[IRB 18-19, Gonzalez-Mosqueda, Exempt Letter, Page 2]

Any signed consent documents must be retained for at least three years to enable research compliance monitoring and in case of concerns by research participants. Consent forms may be stored longer at the discretion of the principal investigator [PI]. The PI is responsible for retaining consent forms. If the PI is a student, the faculty supervisor is responsible for the consent forms. The consent forms must be stored so that only the authorized investigators or representatives of the IRB have access. At the end of the retention period, the consent forms must be destroyed [not re-cycled or thrown away]. Please destroy all audio tapes after scoring if applicable.

Isabel Sumaya, University Research Ethics Review Coordinator

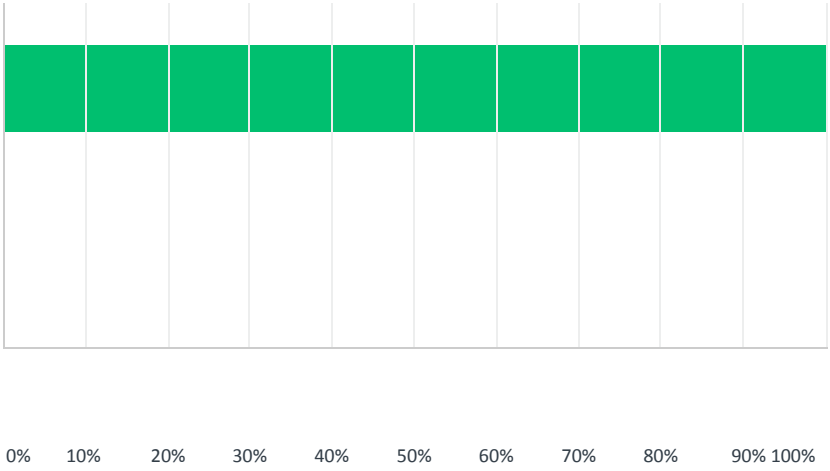
Appendix B

Online Survey Responses

SURVEY: IMPACT OF MESA THROUGH STEM EDUCATION

Q1 Do you take or have taken courses at Bakersfield College?

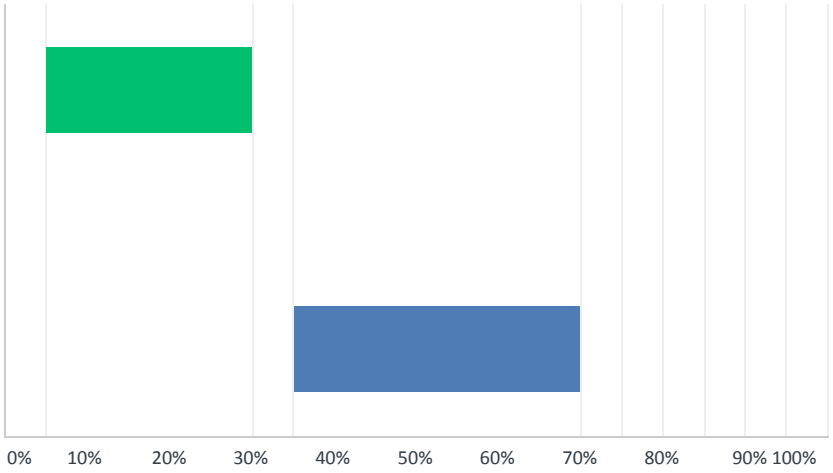
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	100.00%	145
No	0.00%	0
TOTAL		145

Q2 Are you a student currently enrolled in the BC's MESA program? Check one

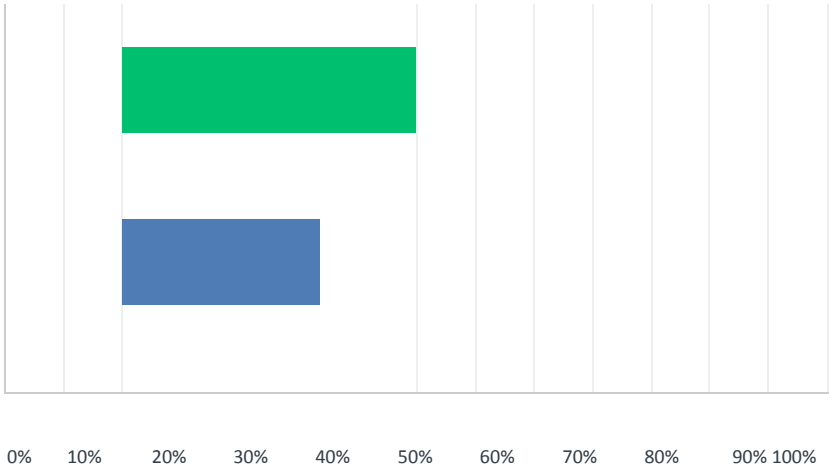
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	35.17%	51
No	64.83%	94
TOTAL		145

Q3 Are you MESA alumni? Check one

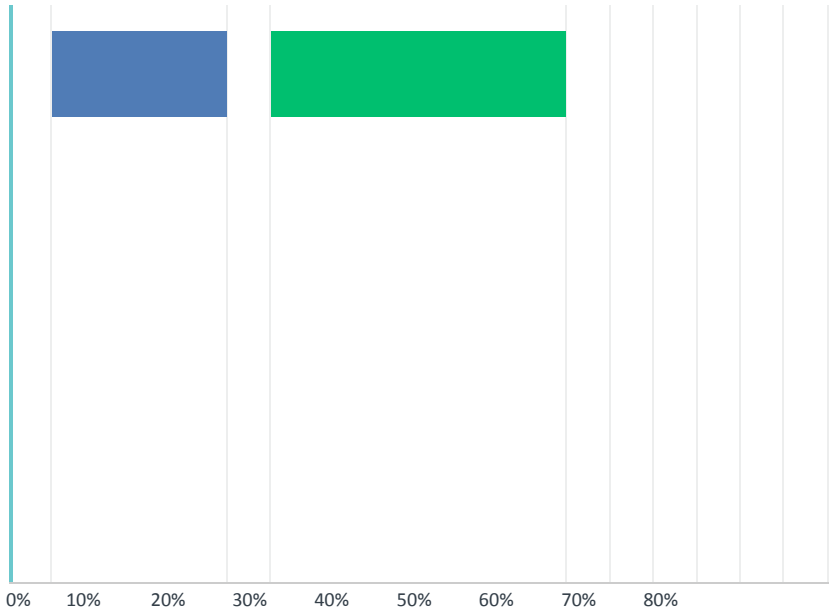
Answered: 147 Skipped: 0



ANSWER CHOICES	RESPONSES	
Yes	55.78%	82
No	44.22%	65
TOTAL		147

Q4 What is your gender? Check one

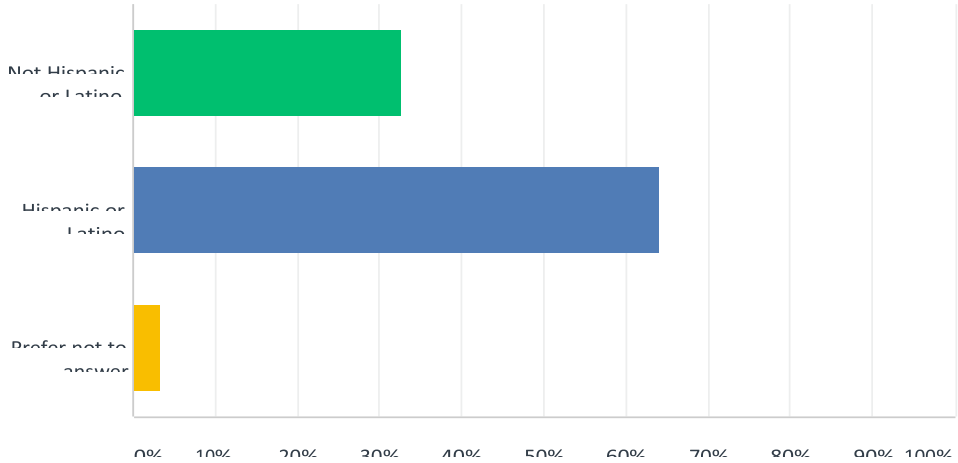
Answered: 147 Skipped: 0



ANSWER CHOICES	RESPONSES	
Male	65.99%	97
Female	31.29%	46
Prefer not to answer	2.04%	3
Other (please specify)	0.68%	1
TOTAL		147

Q5 What is your ethnicity?

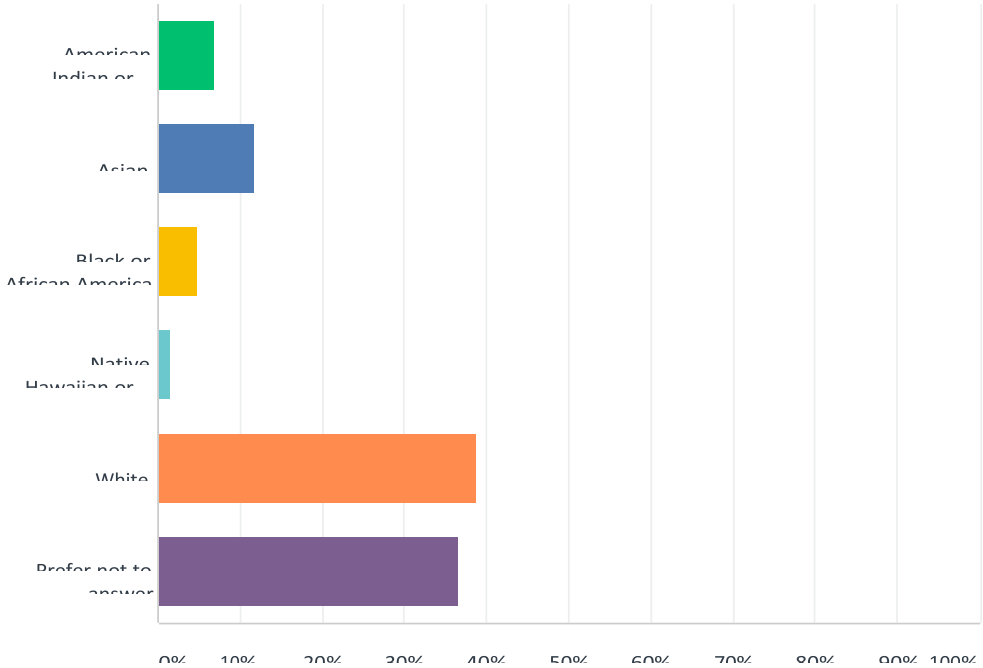
Answered: 147 Skipped: 0



ANSWER CHOICES	RESPONSES	
Not Hispanic or Latino	32.65%	48
Hispanic or Latino	63.95%	94
Prefer not to answer	3.40%	5
TOTAL		147

Q6 What is your racial background?

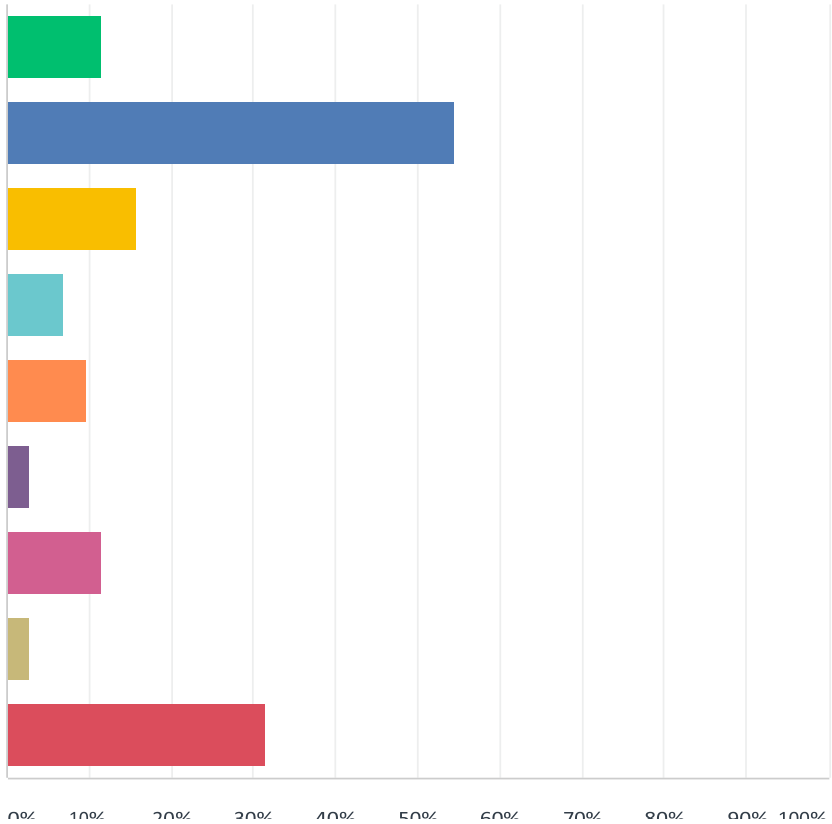
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
American Indian or Alaska Native	6.90%	10
Asian	11.72%	17
Black or African America	4.83%	7
Native Hawaiian or Other Pacific Islander	1.38%	2
White	38.62%	56
Prefer not to answer	36.55%	53
TOTAL		145

Q7. Please indicate the major enrolled in Or the degree(s) earned from the STEM fields (Check all that apply).

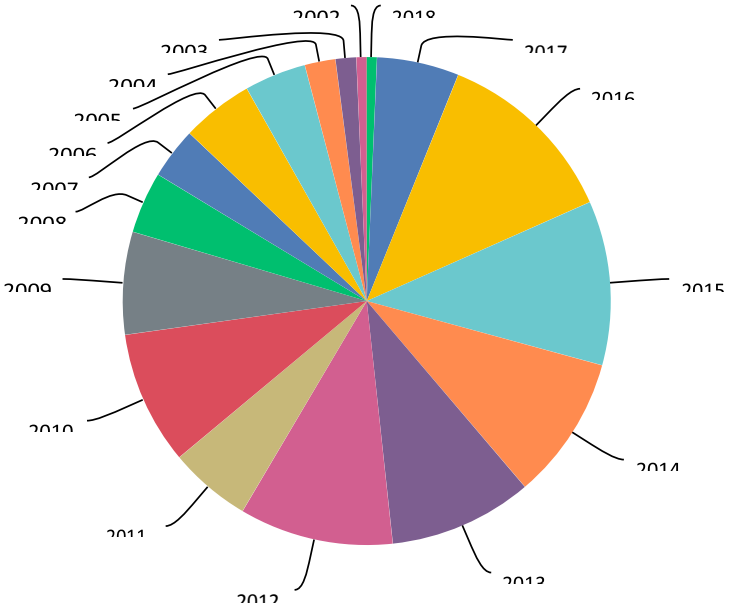
Answered: 147 Skipped: 0



ANSWER CHOICES	RESPONSES	
Computer Science	11.56%	17
Engineering	54.42%	80
Life Science	15.65%	23
Physics	6.80%	10
Chemistry	9.52%	14
Geology	2.72%	4
Mathematics	11.56%	17
Technology	2.72%	4
Indicate branch of Life Science, Engineering or Technology	31.29%	46
Total Respondents: 147		

Q8 What year you started college?

Answered: 147 Skipped: 0

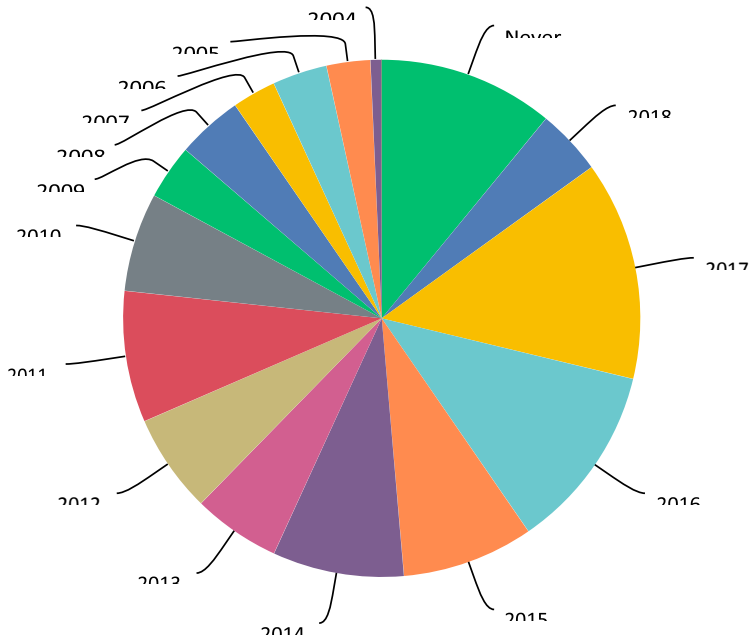


ANSWER CHOICES	RESPONSES	
2018	0.68%	1
2017	5.44%	8
2016	12.24%	18
2015	10.88%	16
2014	9.52%	14
2013	9.52%	14
2012	10.20%	15
2011	5.44%	8
2010	8.84%	13
2009	6.80%	10
2008	4.08%	6
2007	3.40%	5
2006	4.76%	7
2005	4.08%	6
2004	2.04%	3
2003	1.36%	2
2002	0.68%	1

2001	0.00%	0
2000	0.00%	0
90's	0.00%	0
TOTAL		147

Q9 In what year you enrolled in the MESA program?

Answered: 146 Skipped: 1

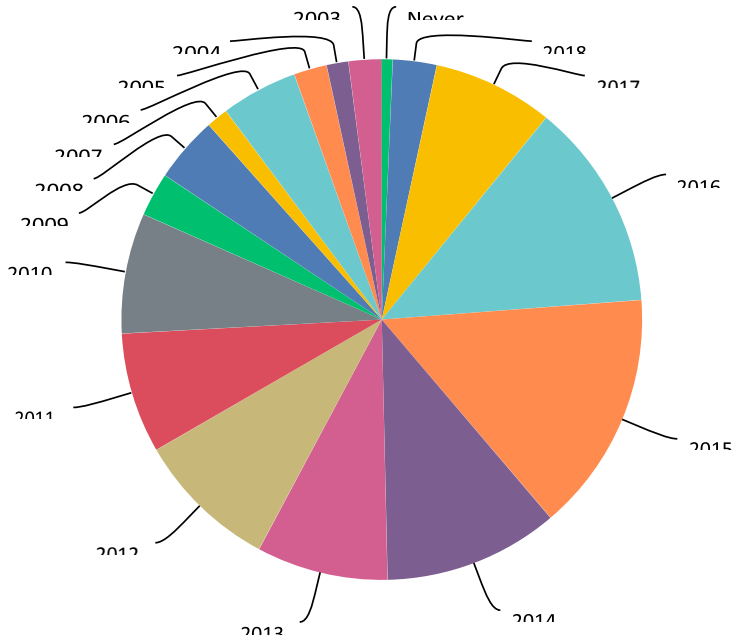


ANSWER CHOICES	RESPONSES	
Never	10.96%	16
2018	4.11%	6
2017	13.70%	20
2016	11.64%	17
2015	8.22%	12
2014	8.22%	12
2013	5.48%	8
2012	6.16%	9
2011	8.22%	12
2010	6.16%	9
2009	3.42%	5

2008	4.11%	6
2007	2.74%	4
2006	3.42%	5
2005	2.74%	4
2004	0.68%	1
2003	0.00%	0
2002	0.00%	0
2001	0.00%	0
2000	0.00%	0
90's	0.00%	0
TOTAL		146

Q10 What year you declared the STEM major you choose?

Answered: 147 Skipped: 0

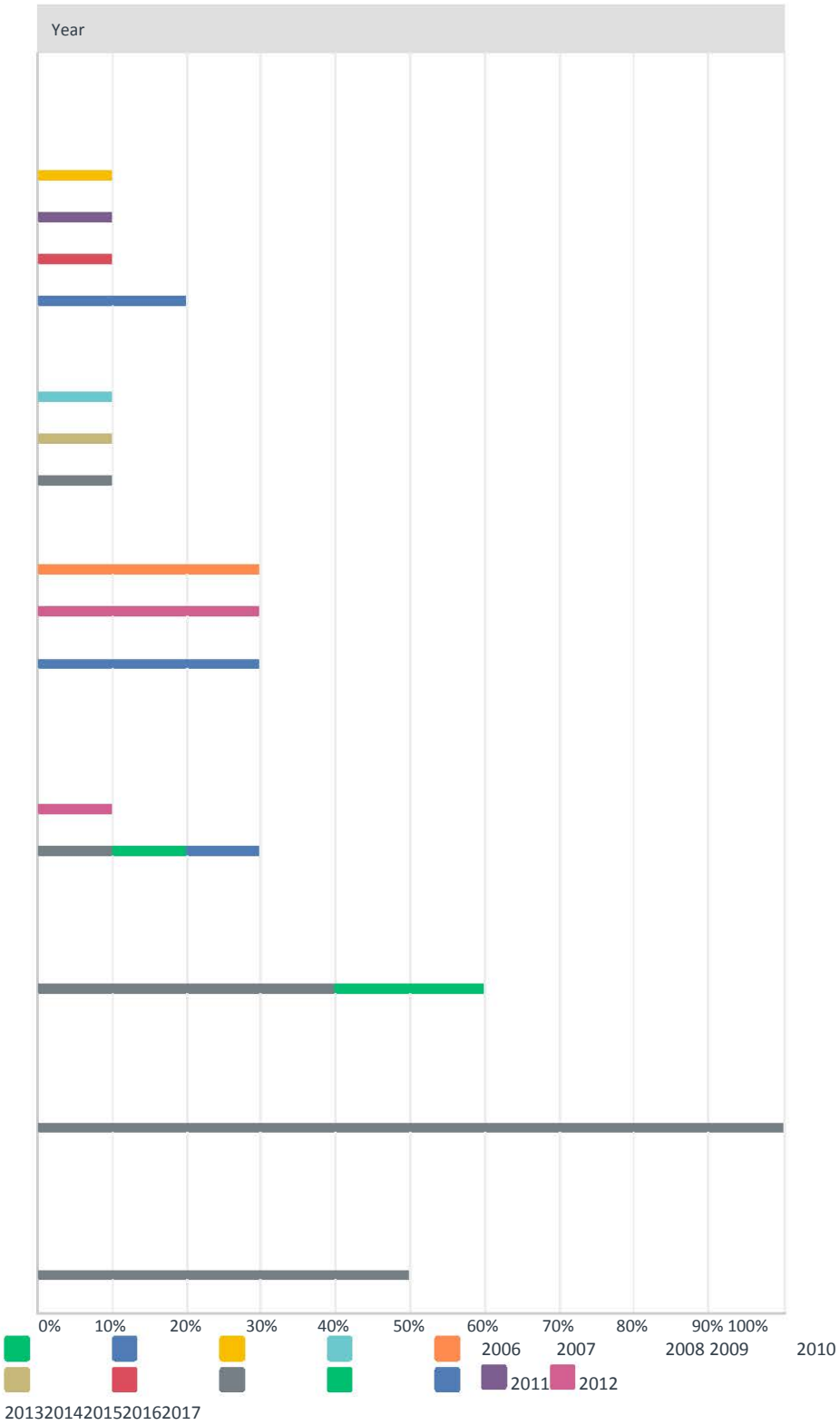


ANSWER CHOICES	RESPONSES	
Never	0.68%	1
2018	2.72%	4
2017	7.48%	11

2016	12.93%	19
2015	14.97%	22
2014	10.88%	16
2013	8.16%	12
2012	8.84%	13
2011	7.48%	11
2010	7.48%	11
2009	2.72%	4
2008	4.08%	6
2007	1.36%	2
2006	4.76%	7
2005	2.04%	3
2004	1.36%	2
2003	2.04%	3
2002	0.00%	0
2001	0.00%	0
2000	0.00%	0
90's	0.00%	0
TOTAL		147

Q11 If you have graduated, indicate the year graduated for each degree completed

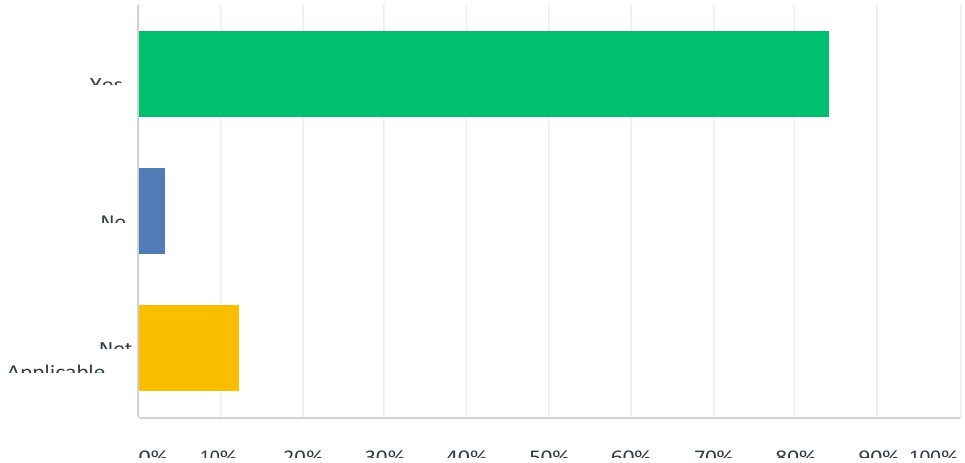
Answered: 72 Skipped: 75



Year													
	2006	**2007**	**2008**	**2009**	**2010**	**2011**	**2012**	**2013**	**2014**	**2015**	**2016**	**2017**	**TOTA**
A.S	2.94% 1	0.00% 0	2.94% 1	11.76% 4	0.00% 0	14.71% 5	2.94% 1	8.82% 3	8.82% 3	14.71% 5	11.76% 4	20.59% 7	
A.A .14%	7.14% 1	7.14% 1	7.14% 1	7.14% 1	7.14% 1	14.29% 2	0.00% 0	14.29% 2	0.00% 0	14.29% 2	14.29% 2	3 7	
B.S	0.00% 0	0.00% 0	0.00% 0	2.17% 1	4.35% 2	2.17% 1	10.87% 5	15.22% 7	8.70% 4	8.70% 4	17.39% 8	30.43% 14	
Masters in Science	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	33.33% 1	66.67% 2	0.00% 0	
Other Masters	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	100.00% 2	0.00% 0	0.00% 0	
Ph.D .00%	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	0.00% 0	50.00% 1	50.00% 1	0 0	

Q12 Do you believe the MESA program has assisted you to obtain a STEM education?

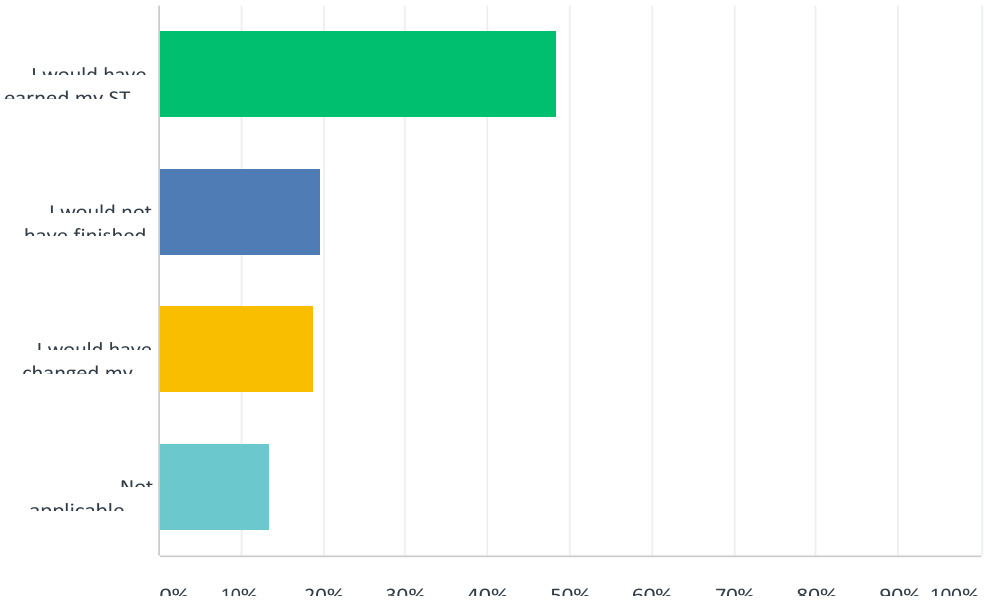
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	84.14%	122
No	3.45%	5
Not Applicable, I was not in the MESA program	12.41%	18
TOTAL		145

Q13 Which statement best describes what probably would be your highest college degree attained today if you had not enrolled in the MESA program?

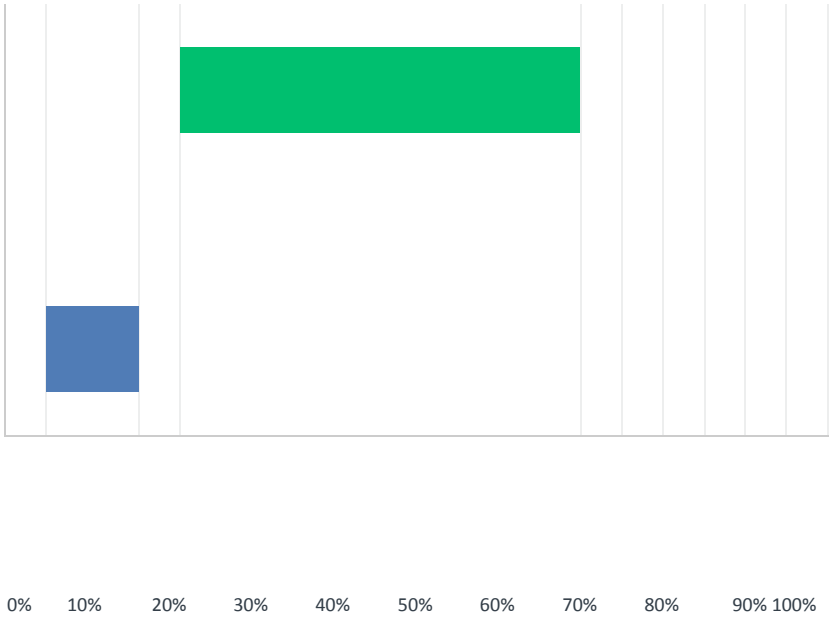
Answered: 143 Skipped: 4



ANSWER CHOICES	RESPONSES	
I would have earned my STEM degree no doubt	48.25%	69
I would not have finished a STEM degree	19.58%	28
I would have changed my major to a Non-STEM degree	18.88%	27
Not applicable, I was not in the MESA program	13.29%	19
TOTAL		143

Q14 Do you plan to complete additional educational programs?

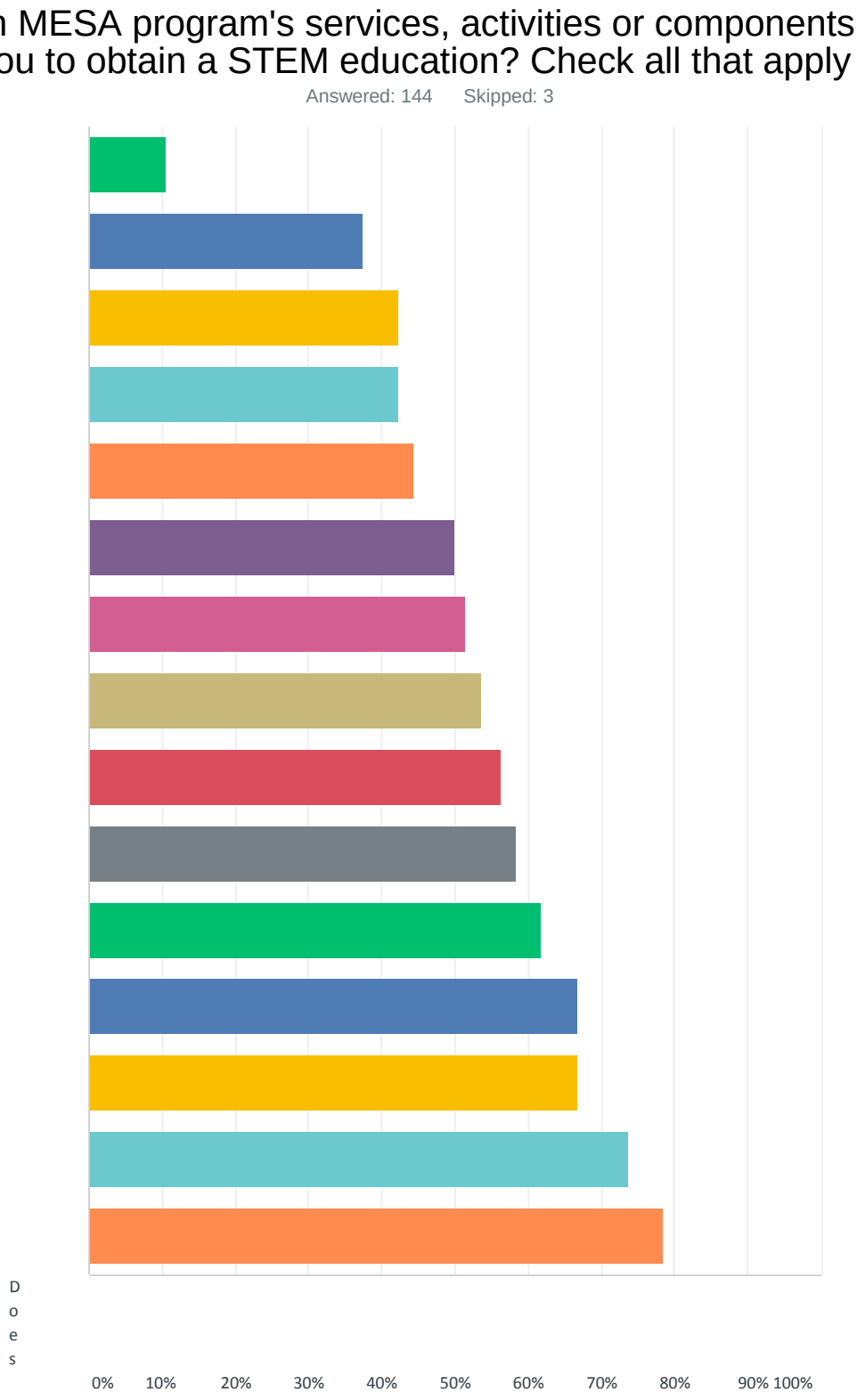
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes	78.62%	114
No	21.38%	31
TOTAL		145

Q15 What is your current occupation or job description?

Answered: 137 Skipped: 10


Q16 Which MESA program's services, activities or components assisted you to obtain a STEM education? Check all that apply
Answered: 144 Skipped: 3
Does
0%
10%
20%
30%
40%
50%
60%
70%
80%
90%
100%

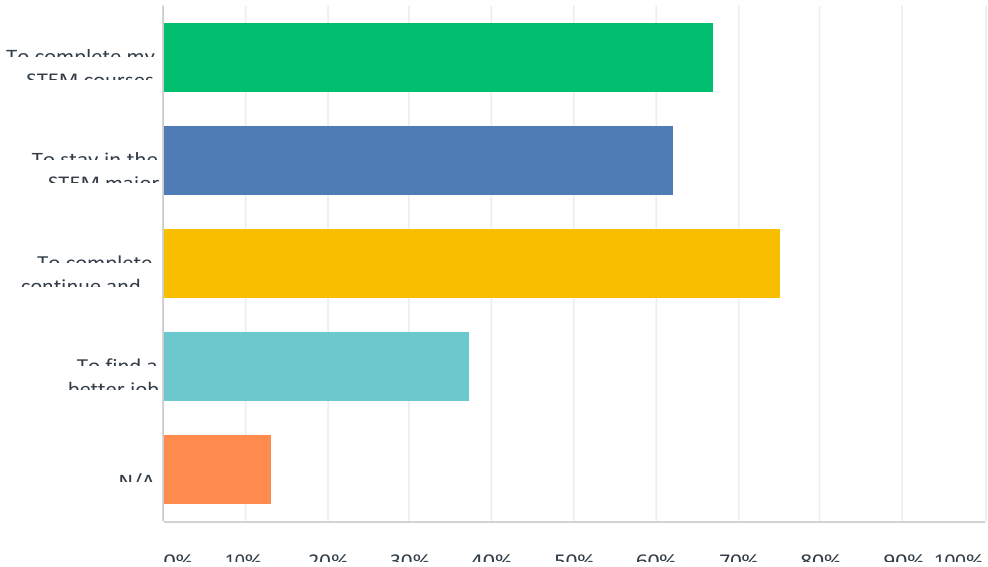
ANSWER CHOICES	RESPONSES	
Does not apply, I was not in the MESA program	10.42%	15
MESA Mentor from industry	37.50%	54
Research and Internship Opportunities	42.36%	61
Lockers access	42.36%	61
MESA Field trips to University/Industry	44.44%	64
Book and Calculator Loans	50.00%	72
Academic Excellence Workshops	51.39%	74
Academic Counseling with MESA Counselor	53.47%	77
Lounge, eating area for fridge and microwave	56.25%	81
Guest speakers from Industry and Universities	58.33%	84
MESA Director ‘s mentoring	61.81%	89
Computer access and free printing	66.67%	96
MESA workshops	66.67%	96
MESA Tutors	73.61%	106
MESA Center with study space and whiteboards	78.47%	113
Total Respondents: 144		

17 What is the most important activities that you did in MESA that helped you obtain your degree? (If you have not participated in MESA, please indicate N/A)

Answered: 138 Skipped: 9

Q18 How the involvement in the MESA program's activities benefits me? (Check all that apply) (If you have not participated in MESA, please indicate N/A)

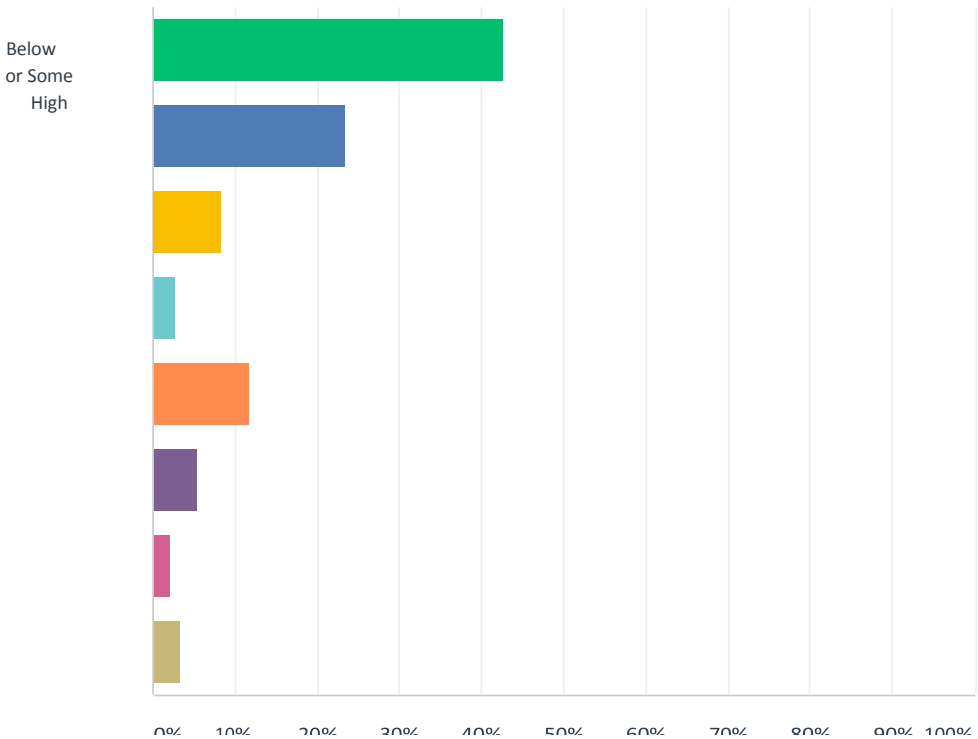
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
To complete my STEM courses	66.90%	97
To stay in the STEM major	62.07%	90
To complete, continue and transfer out	75.17%	109
To find a better job	37.24%	54
N/A	13.10%	19
Total Respondents: 145		

Q19 What is your parents' highest degree earned when you enrolled in MESA?

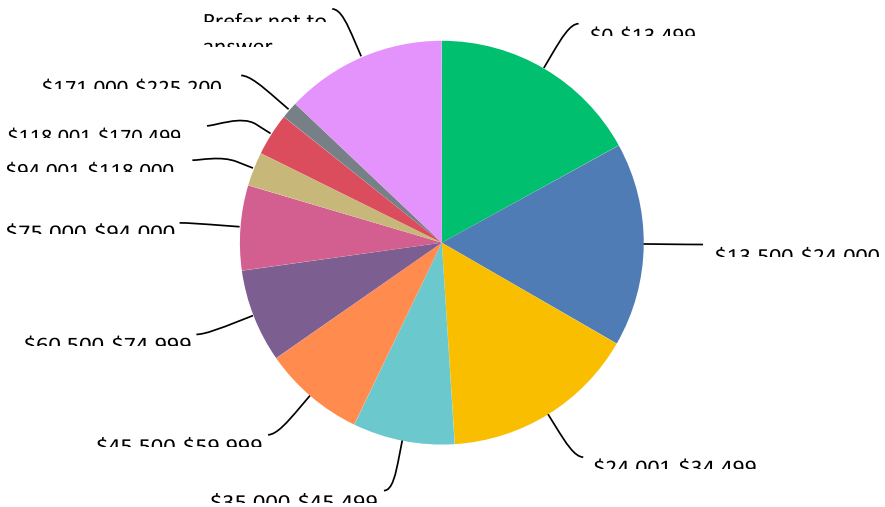
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
Below or Some High School	42.76%	62
High School Graduate or Equivalent	23.45%	34
Some College	8.28%	12
Associates Degree	2.76%	4
Bachelors	11.72%	17
Master	5.52%	8
Ph.D.	2.07%	3
Does not apply, I was not in the MESA program, but I would like to answer	3.45%	5
TOTAL		145

Q20 What was the household income bracket when you declared your STEM degree?

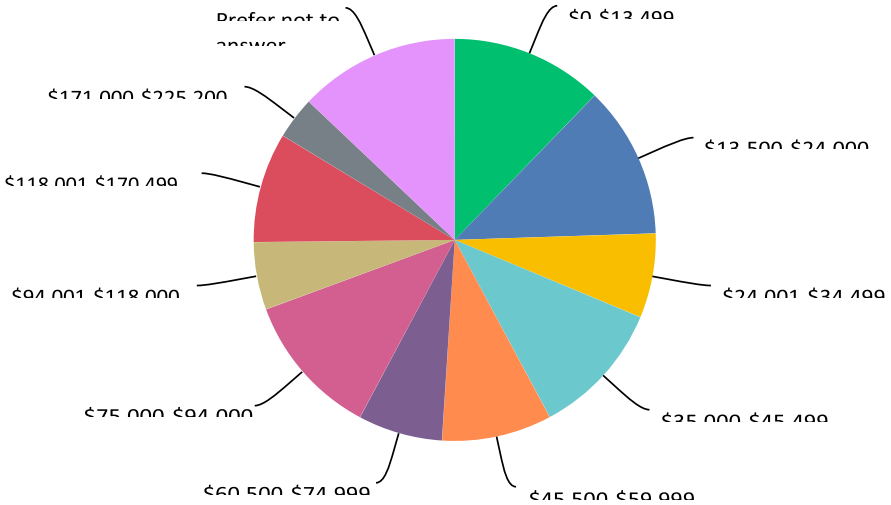
Answered: 147 Skipped: 0



ANSWER CHOICES	RESPONSES	
$0-$13,499	17.01%	25
$13,500-$24,000	16.33%	24
$24,001-$34,499	15.65%	23
$35,000-$45,499	8.16%	12
$45,500-$59,999	8.16%	12
$60,500-$74,999	7.48%	11
$75,000-$94,000	6.80%	10
$94,001-$118,000	2.72%	4
$118,001-$170,499	3.40%	5
$171,000-$225,200	1.36%	2
Above $430,000	0.00%	0
Prefer not to answer	12.93%	19
TOTAL		147

Q21 What is the current household income?

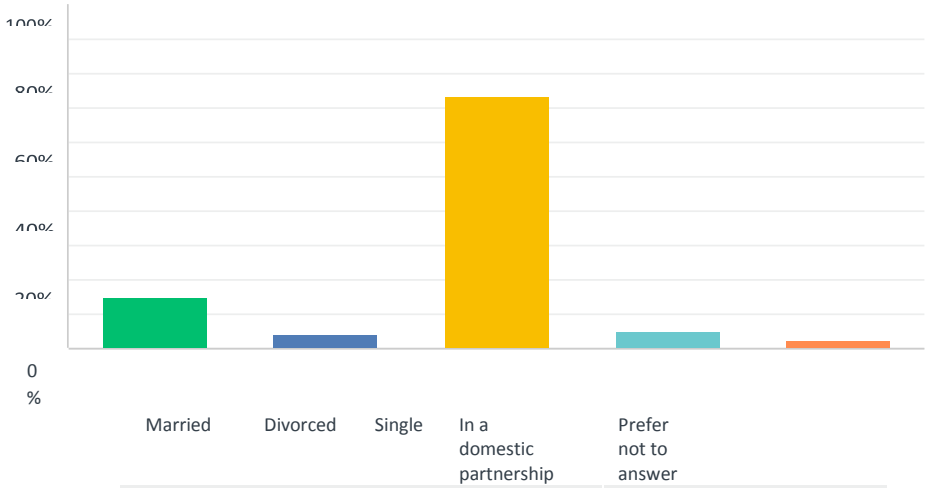
Answered: 147 Skipped: 0



ANSWER CHOICES	RESPONSES	
$0-$13,499	12.24%	18
$13,500-$24,000	12.24%	18
$24,001-$34,499	6.80%	10
$35,000-$45,499	10.88%	16
$45,500-$59,999	8.84%	13
$60,500-$74,999	6.80%	10
$75,000-$94,000	11.56%	17
$94,001-$118,000	5.44%	8
$118,001-$170,499	8.84%	13
$171,000-$225,200	3.40%	5
Above $430,000	0.00%	0
Prefer not to answer	12.93%	19
TOTAL		147

Q22 What is your marital status?

Answered: 147 Skipped: 0



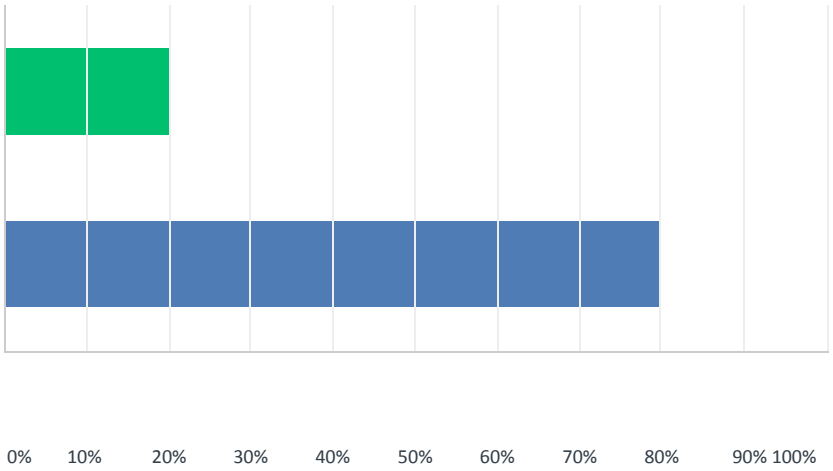
ANSWER CHOICES	RESPONSES	
Married	14.97%	22
Divorced	4.08%	6
Single	73.47%	108
In a domestic partnership	4.76%	7
Prefer not to answer	2.72%	4
TOTAL		147

Q23 Where you currently live? (City, State)

Answered: 146 Skipped: 1

Q24 Do your spouse or partner hold a degree?

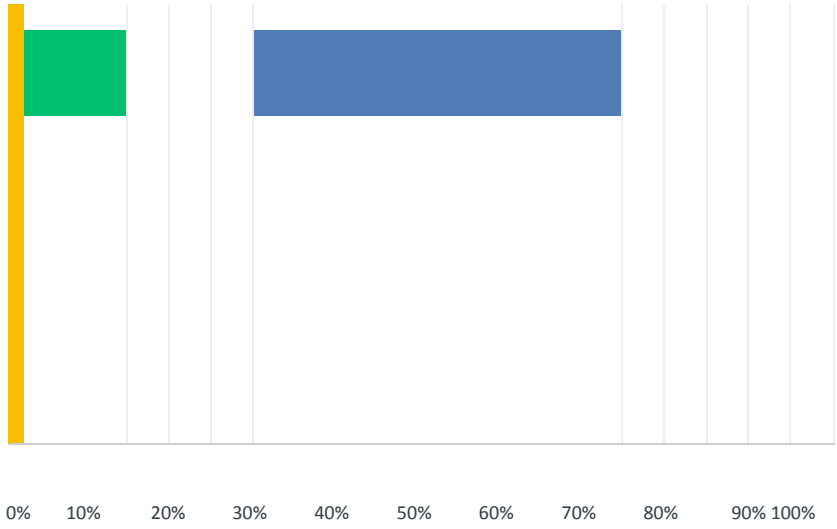
Answered: 128 Skipped: 19



ANSWER CHOICES	RESPONSES	
Yes	20.31%	26
No	79.69%	102
TOTAL		128

Q25 Do you own a home?

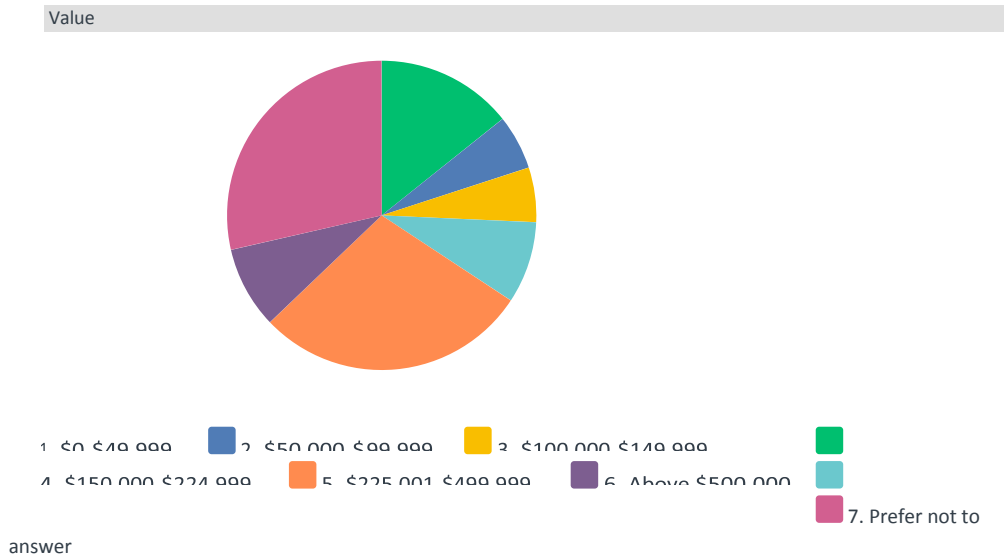
Answered: 145 Skipped: 2



ANSWER CHOICES	RESPONSES	
Yes, I own a home	13.10%	19
No, I don't own a home	84.83%	123
Prefer not to answer	2.07%	3
Total Respondents: 145		

Q26 If you answer Yes to the previous question: Do you a home What is the estimated value?

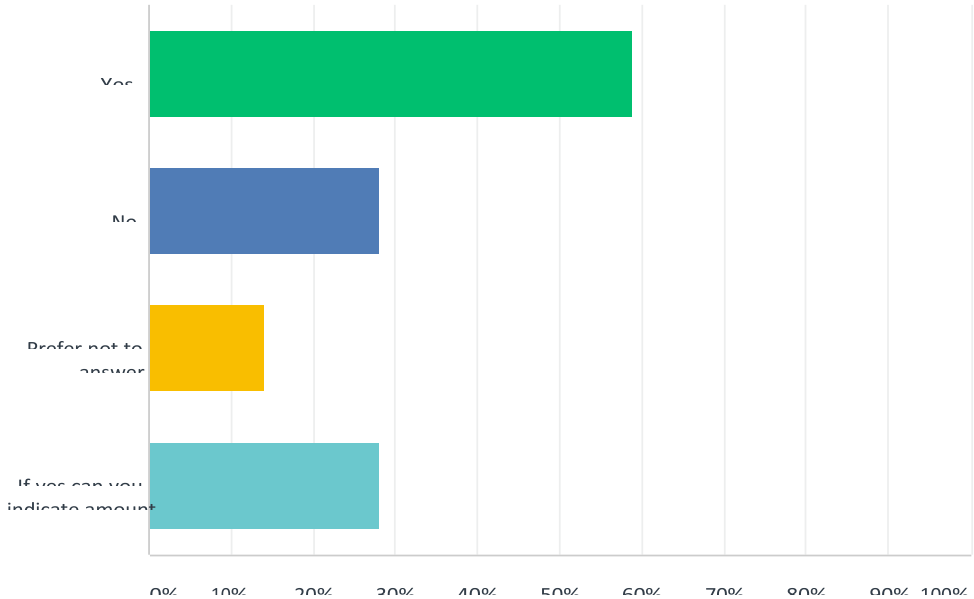
Answered: 35 Skipped: 112



Value	1. $0-$49,999	2. $50,000-$99,999	3. $100,000-$149,999	4. $150,000-$224,999	5. $225,001-$499,999	6. ABOVE $500,000	7. PREFER NOT TO ANSWER	TOTAL
House	14.29% 5	5.71% 2	5.71% 2	8.57% 3	28.57% 10	8.57% 3	28.57% 10	35

Q27 Do you donate money or volunteer hours in your community?

Answered: 143 Skipped: 4



ANSWER CHOICES	RESPONSES	
Yes	58.74%	84
No	27.97%	40
Prefer not to answer	13.99%	20
If yes can you indicate the amount of hours or money donated	27.97%	40
Total Respondents: 143		

Q28 Thank you for your time! Please feel free to add any additional comments

Answered: 53 Skipped: 94