MESA Center Promoting Technical Literacy

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Abstract

In 2007, the first MESA Center in Texas opened at our college. After twelve years, there is a story to be told and to be proud of it.

MESA, which stands for Mathematics, Engineering, and Science Achievement, is a national program that originated in California in 1970 [1], [2]. Its purpose is to support educationally disadvantaged students throughout the education pipeline to excel in math and science so they can go on to attain degrees in the fields of engineering, science, and mathematics. Due to its STEM foundation, the MESA Center is also a focal point in the process of promoting technical literacy.

In a society that becomes more and more dependent on technology, the center has made one of its fundamental goals to provide every student with the ability to understand the social, political, economic, and ethical implications of new technological developments. Since its inception, it has served as a catalyst for student study groups and a central location for promoting student scholarships, engineering design competitions, internships, summer undergraduate research opportunities, and a variety of activities promoting technical literacy on our campus. The Center has been host to tutoring sessions for difficult courses, student success seminars, resume writing and job search workshops, as well as meetings of several sciences and engineering-oriented student organizations on our campus. The Center has also served as a forum for presentations by faculty and student researchers, university recruiters, and practicing professionals from our area. All these activities promoted relentlessly technical literacy among the students at our college.

This paper will present examples of activities, analyze the students’ participation, the challenges encountered, and the encouraging results of twelve years of the continuous presence of the MESA Program at our community college, as well as outline some of our future plans.

Introduction

As a Hispanic Serving Institution with over 62% minority enrollment, San Antonio College (SAC) had the honor of opening the first MESA Program in Texas [3], [4] in 2007. It was the first and still is the only MESA Program in Texas. From the beginning it was a center that continuously promoted technical literacy and being coordinated by our Engineering Program, it was also one of our major promoters and recruiters for students to pursue careers in STEM fields and particularly, in engineering. Its mission was, and still is, to help and support students become scientists, engineers, and mathematicians responding to a growing national need for qualified technical professionals.

Background

The term “technological literacy” refers to one's ability to use, manage, evaluate, and understand technology (ITEA, 2000/2002) [5]. In order to be a technologically or technically literate citizen, a person should understand what technology is, how it works, what effect it has on society and in turn what effect society has on it.
As our society becomes increasingly technologically dependent, the vast majority of the population becomes increasingly ignorant of the way the technology works and how it directly affects society. At the beginning of the new millennium, the National Academy of Engineering together with the National Research Council published a report showing that science and technology had a continuously increasing role in the everyday life of our citizens and initiated a major effort to define cultural and scientific literacy [6]. A review of the way the public generally understands the results of scientific research reveals the disconnection between science literacy and society. Current issues related to Global Warming, Green Energy, Pollution, Genetic Engineering, and even the importance of vaccinations show a great disconnection between Society and Science and now, more than ever, our future depends on how we will address these vital issues [7].

Activities initiated by our MESA Center that support technological literacy

The ITEEA 2000 Standards [8] were developed to help introduce technological literacy in the education process. They are divided into five main categories that sub-divide into 20 specific standards. The five main categories used to define technological understanding include:

1. Understanding the Nature of Technology,
2. Understanding of Technology and Society,
3. Understanding of Design,
4. Abilities for a Technological World, and
5. Understanding of the Designed World.

From the beginning, our MESA center developed multiple activities inspired by these standards to expand students’ technical literacy and increase their awareness of various engineering and technical careers. Over the years, the MESA program membership and student participation have grown steadily. Our students have developed extended social support networks through the STEM-focused clubs like Mexican American Engineers and Scientists-Latinos in Science and Engineering (MAES), Society for Advancement of Chicanos/Hispanics and Native Americans in Science (SACNAS), Society of Women Engineers (SWE), and Society of Physics Students (SPS).

The activities at the center that are vital to increasing students’ technical awareness include field trips, undergraduate research, conferences and seminars, volunteering activities, guest speakers, career orientations and outreach events. Faculty, being constantly involved as advisors and mentors, play a critical role in these activities. Some of the most notable activities are:

- Field trips are activities that put students in direct contact with companies around town that bring the technology to real life. They might be the actual workplaces where our students will be employed after graduation so knowing what the companies are doing might help them decide. Every semester our center schedules two or three field trips for interested students. The field trips are organized on Fridays and some of the favorite places are, Southwest Research Institute, San Antonio Water System facilities, Toyota factory, Precision Mold and Tool Group, H.E.B.,
and Republic Recycling Company just to name the largest ones. The number of participating students varies between 10 and 25 per trip.

- Job-Shadow Days are similar to field trips but they involve engineering and architecture firms that are more representative to the design aspects of the work performed in technical fields. Job-Shadow Days have been organized once every fall semester for the last six years. The number of participants, students, and companies grew constantly every year from 51 students and 6 companies in 2014 to 87 students and 11 companies in 2019. Several companies already hired or accepted for internships several of our students.

- SPS meets weekly for “Fun with Physics Fridays” where students engage in activities that include training to operate telescopes at the 22,000 square-foot Scobee Education Center, which is a first-of-its-kind, next-generation Challenger Learning Center with a planetarium and rooftop star deck and observatory. Students volunteer to operate the telescopes for the public on Friday nights.

- Every semester, depending on availability, at least one speaker presents a company profile or a specific job function as it relates to a technology field. Depending on the time of the day and the day of the week, the students’ participation varies from five up to 30 students.

- The Science of the Olympics is an occasional activity initiated by students whenever they are interested to learn more about the science of the sports in which video clips created by the NSF, NBC, NHL, and other agencies are presented and analyzed.

- The professional development workshops include club officers’ retreats, e-portfolios management, scholarship essays, transfer tips, and research paper sessions together with more general subjects as resume writing, interview training, and creating a LinkedIn profile. In 2017, 98 students participated in these workshops; in 2018, 94 students participated. Faculty donates the current technical magazines they receive to the MESA Center for students to read and keep abreast on their fields of interest.

- Because families wonder why the students spend a large amount of their free time at the MESA Center, Family Night was implemented to share some of the projects in a fun, engaging and interactive environment. This is an excellent opportunity to expand the reach of our technology literacy efforts outside of our school environment. On average 15 to 30 families participate in this event.

- Core4STEM Program [9] is a three-day celebration of education and career opportunities in “STEM” organized by the San Antonio Hispanic Chamber of Commerce. Since its inception, ten years ago, its mission is to stimulate students’ interest in the sciences and lead them to discoveries about their own potential in these areas and provides immersion in the excitement, surprise, and fun inherent in the sciences. Every year our MESA students were prominent participants in this event with an average of 10 students volunteering for activities and demonstrations showing science and engineering applications.

- Engineers Week [10]. Since the beginning of the MESA Program at our college, every February our students celebrate the National Engineers Week with Open House activities that include project presentations, technical demonstrations with discussions, tours of our shop area, and career awareness seminars.
Undergraduate research program. Undergraduate research programs are powerful tools that provide major benefits for science, technology, engineering and mathematics (STEM) education such as increased retention, facilitating the learning of complex subjects, and helping students develop life-long study, research, and analysis skills. The program we developed at our college requires that every participating team concludes their research activity with a report, a public presentation of their results, and a poster displaying the entire project. All the posters are then displayed on the hallway where the MESA Center is located so the passing students can see what we are doing (Figure 1).

Figure 1 – MESA Center hallway

As a result, numerous students visited our MESA Center to inquire about subjects that interested them. Many of them joined our MESA Program afterward.

After ten years, as our program continues to grow, we will continue our work aimed at helping students improve their technology literacy skills along with developing research and critical analysis of soft skills.

Results

As a result of our continuous efforts to increase the technological literacy and engineering awareness among our students, the MESA Program registered success after success and helped grow the Engineering Program, based on students’ declared majors, to become the fifth-largest program in our college.

In the academic year 2009-2010, 368 students made 3,563 visits to the center, while in the academic year 2018-2019, the overall number of students was 668 with 5,287 visits to the center. All this amounts to an increase of 55.09 % in individual student participation with a 67 % increase in student visits (Figure 2).
Another important result demonstrating the success of our efforts is that, overall, 46 undergraduate research projects have been performed on our premises since the inception of this program. Close to 200 participating students have been directly involved in STEM-related research activities and actively promoted technological literacy among our student population.

The undergraduate research program at SAC [11] - [14] has grown almost 300% since 2010 as shown in Figure 3. During the summer of 2010, three teams and a total of 10 students were engaged in undergraduate research activities. In 2019, there were nine teams and 41 students involved and performing research all year round. The increase in participation can be credited to the various National Science Foundation (NSF), National Aeronautics and Space Administration (NASA), and U.S. Department of Education (USDOE) grants that have been awarded to the college in an effort to increase the number of underrepresented minorities pursuing STEM.

In addition, the number of active members in the student section of the SWE at our college grew from five to 20, with many of them being involved in the undergraduate research projects. In fact, SWE members took ownership of the hydroponics projects, which along with the hydrogen fuel cell vehicle projects and the project investigating a possible meteorite impact site, have evolved into year-round research efforts.
When the *Hispanic Outlook on Education* magazine [15] released its annual issue at the beginning of the fall semester ranking “Top Schools for Hispanics”, San Antonio College placed in the Top 20 among two-year colleges for Hispanic Enrollment and placed twice in the “Top 10 for Majors” category - once for computer information systems and once for engineering as well.

Challenges in Helping Students Improve Their Technical Literacy

At community colleges, faculty do not receive reduced teaching load for participating in research or extracurricular activities so their participation is on a voluntary base. Community college faculty also does not have graduate students and post docs to assist with supervising undergraduate projects. Community college faculty are focused on teaching and are not encouraged to be involved in the kind of activities that MESA Center is offering. Some of the students’ limitations include weaknesses in soft skills such as time management, teamwork, and communications, make balancing of school requirements, MESA activities, family, and outside jobs, a very difficult task. At times, this results in students dropping out of projects. Many students may have family, financial, or health challenges that may prevent them from continuing their participation. For example, a student’s lack of research experience can lead to underestimating the time required for a project, resulting in missed deadlines and at times, creating real conflicts with students’ classes, family commitments, and outside employment. Research projects and the extracurricular activities can have a negative impact on a student’s GPA if they are not properly advised and projects are not effectively managed. Finally, community college students do not get any curriculum credit for their involvement in MESA activities as students do for various projects at 4-year institutions. All these challenges have a negative impact on students’ ability to gain a broad and consistent technical literacy.

A survey inspired by the ITEA Standards for Technological Literacy and The National Assessment of Educational Progress (NAEP) [16] conducted by the author at the beginning and end of an introductory technology literacy course at University of Texas at San Antonio [17], similar to a survey conducted at Our Lady of the Lake University [18], was updated and conducted in several classes at San Antonio College. The new survey was built to evaluate four basic skills related to Technological Literacy: critical thinking skills (4 questions/ 9 points), communication skills (4 questions/ 4 points), empirical and quantitative skills (5 questions/ 6 points), and social responsibility (7 questions/ 11 points) for a total of 20 questions and 30 points (Appendix 1). The survey did not identify the gender or ethnicity of the participants but they were asked if they were members of the MESA program or not.

The survey has been completed by 115 students out of which 41 were MESA members and 74 were not. The survey revealed the same general trend observed by other studies that a majority of students lack a generally good understanding of the dual interaction between technology and society [19] - [23].

The analysis of the survey results is presented in Figure 4. The answers were combined for analysis grouping the correct answers together with the correct but unsure ones and the wrong answers together with wrong but unsure and no knowledge at all answers. The comparison shows that, although not perfect, the MESA students’ have a slightly better understanding of the interactions between technology and society that would lead to improving their chances to become better citizens.
Overall, the MESA students had 12.43% more correct answers than the general student population. In the four skills categories, the MESA students performed 18.64% better in Critical Thinking Skills, 8.15% in Communication Skills, 4.41% in Empirical and Quantitative Skills, and 11.64% in Social Responsibility compared with the general student population. Although the number of students surveyed was relatively small, a brief statistical analysis reveals that the survey results demonstrate a significant overall improvement of technical literacy among the MESA students compared with the general student population. Since this survey was the first of its kind for our MESA Center, it was an excellent evaluation tool to point us towards the areas where we need to increase our efforts and improve our focus in order to help our students develop a better understanding of the complex interactions between society and technology. We plan to repeat this survey on a yearly base. Our future depends on it!

Conclusions

One of the primary goals of our MESA Center continues to be attracting students to STEM fields and, at the same time, helping them increase their technology literacy by facilitating their learning process and creating an environment conducive to science exploration, creativity, and discovery. With the increase in STEM and engineering enrollment, in particular, the MESA Center creates the foundation of academic support provided by the administration and attracting more funding resources for our growing number of projects and activities. Although the tracking of all the program’s alumni is difficult, the information provided by their colleagues, occasional emails, phone calls, and return visits to the center give us the confidence that our MESA Center helped the majority of our students achieve their desired educational goals. Their success demonstrates what is possible when the students, faculty, administration, and the support personnel work together to create more opportunities to develop a program that helps students be better prepared to understand better the complex interactions between technology and society. It is expected that the MESA Program at San Antonio College will continue to grow as we embark on even more diverse and challenging activities in the future.
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Appendix 1: Sample Survey with Answers
Technology and Society Interaction Awareness
General Assessment

Please read the following questions and answer only the ones for which you are confident that you know the correct answer. Do not guess since this is a test to evaluate your level of knowledge. If you do not know the answer, draw a line after the question. If you are not sure if the answer is correct place a question mark before writing the answer.

Critical Thinking Skills

Question 1: List three advantages of genetically modified foods:

Better quality and taste, longer shelf life, shorter growth time, resistance to draught and diseases, nutrition benefits

Question 2: What mode of transportation has done more to change the way cities are built than any other? The Elevator

Question 3: Is Global Warming real or not? Yes

Question 4: List four disadvantages of nuclear energy:

Radioactive waste, nuclear accidents, nuclear radiation, high cost, security risk, fuel availability, non-renewable

Communication Skills

Question 5: In what century did the Industrial Revolution start? XVIII century

Question 6: What major trend in home building was the direct result of the invention of the vacuum cleaner? Full room carpeting

Question 7: What invention helped Alfred Nobel found the Nobel Prize? Invention of Dynamite

Question 8: What is the estimated median number of on-line friends the members of the “Millennial Generation” have? 250-300

Empirical & Quantitative Skills

Question 9: How many days does a light year have? 365 days or None, it’s a distance

Question 10: What major change has been implemented on passenger ships after the Titanic disaster? Each ship must have enough life-boats for all passengers and crew.

Question 11: Why do traditional lightbulbs use more energy than the modern ones? They use heat to generate light so they are in fact heaters.
Question 12: Name two similarities between sailboats and submarines:

Both use buoyancy to stay afloat, both need a propulsion system, both are quieter than regular motor boats, both need a captain, both have to obey the navigation rule, both transport people

Question 13: When astronauts are on the Moon what is the average time between the Earth’s “rise” and “set,” as we here on Earth see the Moon rise and set? The Earth never sets on the Moon.

Social Responsibility

Question 14: Provide one example of how Internet invades privacy.

Tracking your on-line activities, sharing your information with interested companies, allowing unknown people to see your profile

Question 15: Provide two examples that Internet connects people:

Networking, e-mail, access remote information, chat rooms, entertainment, Facebook, Instagram, Twitter, LinkedIn

Question 16: Provide two examples that Internet isolates people:

More time spent on Internet, less time spent with live people, on-line shopping, people have less social skills

Question 17: Provide two advantages of electric cars:

Zero emissions, quiet, less maintenance, can be recharged over night at home

Question 18: Provide two disadvantages of electric cars:

Long time to recharge, heavier, limited recharging options on the road, more expensive, less autonomy

Question 19: About how many endangered species do you think there are that are being threatened with extinction? 16,300

Question 20: About how many national parks are in the United States? 60

Total points: _________

Are you a MESA member? Yes No