

# Students choice of stem fields education essay



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Abstract- In this paper we study the interest of students in the United Arab Emirates (UAE) from grade 9 to 12 in Science, Technology, Engineering, and Mathematics (STEM). Surveys were distributed to students who chose STEM tracks and students who chose non STEM tracks in public and private schools, as well as universities, across the country. The data collected revealed a number of reasons that make students like, or dislike, scientific majors. These reasons include the presence or absence of capable teachers, the influence of role models and the choice of the teaching language. The results presented in the paper also focus on differences between public and private institutions, male and female students, as well as nationals and non-nationals. We also compare our findings to similar research done in the USA. We show that several factors remain valid in both countries whereas others are specific to each of them. This paper also provides suggestions on the way to overcome the challenges in STEM field. Although this paper is based on data collected in United Arabs Emirates, the solutions can be applied to any other region of the world.

**Keywords – STEM; Students survey; Engineering; UAE; Self efficacy; Role models; Peers; Parents, K-12.**

## **Introduction**

Many countries are currently attempting to improve their school systems, making the teaching of Science, Technology, Engineering, and Mathematics (STEM) more important. This is seen as the key educational ingredient that will ensure innovations in future [1-6].

The suggested trend for 21st century national economies is to reach the penultimate label of being “ innovation based” or “ knowledge based” [1, 2].

According to the much heralded and respected “ The Global Competitiveness Report” from the World Economic Forum, an innovation-driven state of any economy is the most sophisticated level to which it matures [1-3]. An innovation-driven economy is judged based on the sophistication of business and its ability to nurture technological creations [1-4]. The scientific survey points to the fact that in order for economies to be “ innovative”, they must possess an advanced education system. Without this, innovation will be unobtainable [1-4].

In a concerted effort to diversify and strengthen its rising oil-based economy, the United Arab Emirates (UAE) has taken upon itself to revamp its whole education system, especially in instruction of science, technology, engineering, and mathematics [4, 7]. The United Arabs Emirites is not a leading contributor in science and technology developments in the Middle East [7, 8]. Though there has been debate over the nature, scale, and to a degree the existence of this problem, most experts seem in agreement that the problem is real and increasing with time [9, 10]. In UAE, the lowering trend of STEM interested students attaining degrees will negatively affect the workforce available for industry [4, 8]. Therefore, UAE’s educational system must provide highly skilled STEM workers in order to reach its 2030 Vision of becoming a self-sustaining and innovative economy [4]. Although STEM subjects may be taught with the utmost vigor and high aspirations, this does not guarantee that the students will major in STEM fields and become innovative and productive members of STEM professions [5, 6]. There are many barriers or “ switch-off” factors that affect students’ choices of studies for further education and/or future careers.

This paper consists a starting point for an ongoing research into modeling the interest of UAE's students in the STEM, as done in [5] with regards to the USA education system.

The paper is organized as follows:

In Section 2, we discuss previous results in literature related to the topic.

In Section 3, we introduce the research methods adopted for the sake of collecting the required data.

In Section 4, we analyze the results and compare our findings to existing ones.

In section 5, we provide the results and the conclusions arrived at from the study

In section 6, we provide various suggestions on solving the existing problems.

In section 7, we provide the limitations of the study.

In section 8, we conclude with several remarks and an outlook for upcoming research projects.

## **BACKGROUND INFORMATION**

Recently, there has been existence of initiatives and publications related to the overall understanding and the experiences of minority particularly doctoral students. The University of Arizona researched the considerations that students take as they decide to apply to a course in a graduate school

[11]. The sample population of the research comprised of students who applied in Arizona and the responses varied out by gender and race (Minority versus White). The top aspects for all applicants in the doctorate program included department reputation, correspondence between student interests and degree program, research conducted by an individual faculty associate, whether there is accreditation of the program, department's receptiveness to questions, overall school reputation, and other external forces. For the minority, on the other hand, aspects such as recommendations from faculty to other institutions, printed resources from the department, and propinquity to the home of the students were highly vital than they were for the overall population. For minority and women, the reaction of a program to the question posed by the applicant also played a highly crucial role. Therefore, the appropriate recruitment of underrepresented teams demands different training and techniques that what is crucial for the majority set [11].

The University of Maryland has published their judgments about victorious programs to create a diverse doctoral student institution on the organization [12]. Some of the programs include Professoriate (AGEP) and Maryland Alliance for Graduate Education. These programs are modeled around comparable successful programs for graduates at other institutions. From these programs, the researchers found some components to be particularly imperative in sustaining minor students before and after graduating. These components include: preparation of graduate learning (application support and GRE); graduate admission (changing the admission strategies); graduate program selection (factors to take in consideration); peer support (with a student who has advanced in the student's disciplines and also through

interdisciplinary circumstances); summer bridge programs (bonding of students and academic preparation assessment); faculty role models and mentors( from the student's research advisor and from other department); stable and adequate staff support, professional development and financial support (support needed for the student to pursue in his desired discipline); and exposure to the occupation (funding to yield successful minority graduates to campus for a long or short period, funding towards travelling to professional conferences). It is significant to note that these components focus more on altering the doctoral programs in the university, other than of forcing the students to change [12].

In addition to the research done by these universities, some non-academic institutions have put focus on issues relating to students joining universities. The Woodrow Wilson Foundation produced a report in 2005 on minorities in doctoral programs [14] and doctoral programs in general [13]. The Foundation established four vital factors that institutions have put in use for improving doctoral education [13]. These are: new practices (the means at which they can make aspects of doctoral training be developmental); new paradigms (what promotes or discourages truly exploratory scholarship?); new partnerships (improved relationship between the sectors that employ doctorate recipients and academia); and new people (the doctorate should ensure that all people in the population feel incorporated and their researches are socially applicable). Putting these issues into consideration, the Foundation concludes that the doctoral experience will advance for all students despite their gender and race.

Underlying the four factors are four principles studied in the report and that has practical application in the institutions. These principles include: Universities should possess a centralized and strong graduate school with imperative power and budge; the graduates should be seen in a vacuum with little or no concern for how the research is affected by or affects the society; students form different backgrounds should be included in these programs; and there should be regular assess of doctoral programs using rational rewards, objectives and consequences. While some institutions follow these principles, others do not follow them. Therefore, through the analyzed report, the Foundation anticipates causing change in the operations and mentality of these institutions so that they can alter the reality of education.

Also, the Foundation recommends the use of seven principles to improve the experiences and recruitment of minority doctorate students: research, communication, intellectual support, professionalizing experiences, vertical integration, leadership, and mixture of race and gender [14]. It is crucial for programs to communicate efficiently so that they have a position to share best practices and resources. Additionally, students should conduct research in order to analyze how programs work and what to add so that they can perform better than before. Vertical integrations analyzes how k-12, undergraduate, and graduate programs should work together to ensure that students engage often and early with them. The Foundation recommends that, in intellectual support, the doctorate should be socially responsive ad should also improve the picture of the programs so that they can become attractive to a large audience. The issue of professionalizing experiences and

monitoring consists of issues related to the relations between a student and his or her advisors, as well as issues on finance that might push a student away from the chances to interact with his or her professional colleagues. Race and gender principal describes how graduates should try to take in consideration race as well as the requirement in admission, programs, and financial help, other than concentrating on the need as several programs do in order to evade negative views of confirmatory action. Finally, leadership principle focuses on the government and its agencies so that they can provide better oversight and assistance on the use of national funds. Leadership principle imperative for it ensures that there is right usage of funds on the desired programs and people. Whilst some of these principles are close to those suggested by the Foundation, some of them are specifically focusing to the minority experience [14].

The Council for Graduates Schools lately founded the Ph. D. Completion project to scrutinize issues relates to time to degree and retention of students in doctoral programs [15]. This program has corporate funding from Ford and Pfizer. Students in various degree programs from a group of universities were set as a sample population. Then there was the distribution of surveys to get an improved understanding of the experiences of students who graduates and who leave their studies without graduating. From the original research for the project, the satisfying practices that they put across were the utilization of the mentoring, program environment, research processes, mode, and procedures, and financial support. These practices support the points put across by the Woodrow Wilson Foundation.



Finally, a private-public partnership referred to as Building Engineering and Science Talent (BEST) has an analysis of the practices that work well to maintain the underrepresented students in STEM fields [16]. These experimental practices include targeted recruitment, institutional leadership, peer support, personal attention, engaged faculty, bridging to the next point, enriched research experience, and personal evaluation and continuous program [16].

Science education among the United States residents lags extremely behind than that of other developed nations. Implicit notion of this statement is that the quality of science literacy in USA elementary and high schools is not as precise compared to European and Asian countries. Students, specifically those of ethnic and racial descents, have little perceptive of science terms such as DNA and photosynthesis, or even the straightforward fact the earth rotates around the sun. Reasonably, an understanding of a scientific idea is lacking among the entire population but particularly among low income and minority students [17]. Aggravating the circumstance is unawareness on the part of science educators of the slight misconceptions that these students bring to the classroom which make it complex for them to theoretically grab scientific resources. Consequently, the number of competent students to learn science, engineering and mathematics after secondary school graduation is remarkably negligible.

There is the use of aforementioned best observations and practices to inform the questions used in this research. As discussed earlier in the Introduction section, this study seeks to better understand the experiences of STEM and non STEM graduates and the factors that facilitate their decisions to move <https://assignbuster.com/students-choice-of-stem-fields-education-essay/>

along pathways leading towards professoriate. It also focuses on the underrepresented students in the STEM fields and clearly brings out the factors that make students pursue or not to pursue in STEM fields. In order to tackle this to completion, there is the distribution of surveys whose responses will conclude the findings of the study.

## **RELATED WORK**

Various studies exist with different suggestions about the reasons why students choose to study or not to study STEM fields. These studies point out several reasons why students pursue or do not pursue with STEM fields after completion of their secondary education. There exist some cognitive factors that affect students' choice of majors. Firstly, their attitudes and beliefs towards STEM disciplines play a crucial role on this. Emotional, psychological, behavioral and physiological propensities which reveal an individual's perceptions and responses to, interaction with his immediate background define cognitive dispositional features. Earlier studies found that there is relationship between two cognitive aspects in the completion and enrolment of unnecessary (or college preparatory) mathematics and science courses- student's self efficacy concerning science and mathematics topics and their interests in both [18]. More studies [19] show that all ethnic groups possess similar aspirations and positive fields for STEM occupations. On the other hand, as minority students continue with their academic disciplines, their interest in mathematics and science related topics decrease as their achievement in these classes weakens. Self efficacy is another cognitive factor that affects the choice of students major. Empirical researches show that students have a high possibility to sign up for science courses if they

maintain high ranks of self efficacy in the science area [18]. The possibility of choosing science or engineering courses enhances with students' awareness that they possess mathematics background or a solid science and in the certainty that they have the capability to perform best in those disciplines. Self efficacy is the strongest forecaster in the consideration of STEM disciplines as a career choice. Reference [19] validates the motivation and significance of self efficacy in foretelling performance in science and mathematics. Minority students possess lower self efficacy in mathematics and science than the other students. Minority students in STEM fields have complication when it comes to perceiving themselves as scientists, even after expressing their interest in STEM careers [20].

One of the most commonly cited rationales for inspiring students to enjoy STEM subjects is good teaching that involves capable teachers [5, 6, 21-24]. The teacher's " capability" can be defined as his/her role and personality in the approach to delivering the academic curriculum [21-24]. The learning environment, or the relationship between the learner and teacher, dictates the outlook of the potential STEM and non STEM interested students. For example, educators who are aware that memorization of content may not be the best method of assessment for learners and diverse methods of pedagogy should be taken into account to reach multiple intelligences tend to produce students who may be more successful [6, 21-24]. According to reference [25], anxiety of mathematics and science has its origins in teaching and in teachers of science and mathematics. Explaining this, they argue that students do not have anxiety before attending school hence, they relate this to the teaching method and the notion that science and

mathematics is somewhat dreaded from the first years learning of a child. Adults and teachers may emphasize that science related fields are hard, whereas they indicate that the skills attained from the field are vital for future accomplishment. If unqualified teachers are forced to teach science related courses, they project signals to students hence scaring students to pursue or complete these majors [25]. Frequently, students' encounters with STEM can force them to feel incompetent especially when presented by educators who do not like STEM. Some teachers may not possess the preparedness to deal with psychological fear of STEM, nor do they have preparedness to handle the defense strategies and mechanisms their students utilize to defend themselves from appearing to fail in STEM.

Prior academic preparation often affects the student's choice of fields to major. In most cases, student decides that a major in the STEM is not he would like to pursue. The uncertainty to stay enrolled in a STEM field is probably influenced by the student's attending mathematic training prior to registering in an institution and his academic aptitude. More exclusively, student achievement in the structure of a grade point and math SAT performance is in association with the persistence of students in STEM majors [26]. Students who earn high math SAT score do not only perform high ranks of participating in mathematics and science clubs but also enrolled in more advanced courses and were more engaged in math and science activities in secondary school. Students with prior academic preparation in STEM have more chances to pursue in majors of STEM disciplines. Studies also show that lack of enough science and mathematical training at the secondary and elementary level has a negative effect on the

students' interesting secondary mathematics as well as academic preparation, science coursework and in majoring in STEM fields [18, 27]. In conjunction to the aforesaid prevalence of tracking of minority students into the lower class science and mathematics disciplines, it seems that the quality of the academic readiness many minority students receive has a negative impact from the differences among school funding, teacher's quality, and money spent on instructional programs. Minority students in most cases get taught by teachers who do not major in that field or even inexperienced teachers who pursue the fields. Minorities have more possibility of receiving funding discriminations in the K-12 education compared to other students [28]. This is because the systems used for funding do not give equal amounts every student exposing minority students to risk of acquiring less funding. Hence, these students have a greater exposure to high quality, challenging mathematics instructions, further daunting their interest in science or mathematics [28].

Commitment of the student to STEM major also has a role in determining whether the student may pursue the major or not. The emphasis on the student's involvement to a particular major one enrolled, as in STEM), is as crucial as developing an early interest in STEM disciplines in K-12. A tough involvement to a STEM degree is a persuasive predictor of student perseverance [26]. Minorities who express deep satisfaction with science and engineering as their field of study (or committed to STEM careers) have high possibility of persisting in STEM disciplines. Amazingly, though, researcher points that serving as a leader or role model on campus discouraged students' commitment to STEM. The student who put more emphasis on

leadership or services is more likely to turn to non STEM majors. One could contemplate that effort and time that is essential to succeed in mathematics and science related field is very challenging leaving less time for students' social incorporation on college. Involvement in such areas like political groups, student government or athletic support teams pulls students away from their laboratory and study time [29].

Misperception of STEM disciplines also has an extreme effect on the student's decision on the major to pursue. Minority students utilize various criteria when defining an effective curricular program [30]. Non minority student scrutinize general coursework as college or academic preparatory courses and start to develop occupational and educational as untimely as eighth grade and start making occupational pronouncement like engaging in extracurricular activities and college-prep courses. However, minorities perceive overall coursework as separate from extracurricular activities taken at one time during secondary school [30].

Another commonly cited reason why students are turned off by STEM subjects is the obsession to receive " high marks" [31]. Due to the relative difficulty of receiving high grades in STEM classes in comparison to other subjects, students are often discouraged from taking STEM subjects. As a result, students' emphasis on achieving high grades outweighs their interest in taking subjects related to Science and Mathematics. Consequently, they abandon their interest in STEM majors [32].

In addition, many studies provide insight into the " switch-off" factors, showing that they might come from the influence exerted by the parents,

students' peer groups within and outside school, role models and the media. Researchers in [33] suggest that families play a critical role in the career choice of their children. The educational background, occupations and aspirations of the parents are important factors, introducing the concepts of cultural and social capital to this process [34-36]. Encouragement from the parent is one of the strongest forces that facilitate the student's early education aspirations. It is not surprising if a student whose parent studied and worked in STEM field decides to choose STEM discipline as his major. This happens because those parents help to instill the belief that STEM careers are successful and applicable in people's lives. Though in [37] the researchers found no impact on female students from exclusively the level of education of their parents, they did find a vital impact of parental encouragement and support. It is clear that children have a high possibility of choosing gender-atypical courses if their parents have slight education. It is crucial to note that gender stereotyping can result as an influence from parents.

In [21, 38, 39] it has been shown that students are influenced by their peers who often stress the 'uncool' aspects of STEM thus preserving negative stereotyping. Reference [38] found that peer achievement positively affects students' achievement in academic. For instance, a peer attitude towards mathematics increases, so does an individual's attitude towards mathematics. At an early stage of development, parents sustain their place as the premier social power for their kids, but as the children grow, their peers take the influential role [39]. Deviant peers may expose the deviance behavior from one person to another in the peer group. This brings up the

proposal of curriculum tracking: putting students in levels or classes based on their achievement or ability level, or particularly not doing so, turns out to be an appealing topic when scrutinized through the angle of influential peer support. If peers attend the same classes, they have a higher possibility of meeting than if they never shares classes. Added to the overall secondary school spectrum is homophonous character of social networks, a widely accepted phenomenon that measures the tendency of the English proverb that says that ‘birds of the same feather flocks together’. For all students, social life in secondary schools and universities becomes an entire world of challenges and issues [39].

The role of role model is clear when it comes to influencing a student’s choice on the career to major. The idea of role models partly cover that of peers, although a role model can be any other individual who puts inspiration to the student while a peer is a person with similar age with the student or with similar stand in the course of life. Role models in the life of a student can be teachers, parents, peers, people in same the neighborhood, or other kin. Just as with the capability of grouping in classes, some students’ selection of role models is advantageous while not in others. In addition, just like many others factors in life, socio-economic status often determine the opportunities and choices of role models. Role models possess the power to influence children choices of future careers, education, overall behavior, and can condemn or support gender biased judgments, which becomes particularly significant for adolescent girls. As reference [40] explains that, starting from female teachers to female professionals to mothers or other female relatives employed in STEM fields, they offer a tangible image of what



is achievable for adolescent girls in their lives. Family support highly influenced the effect that the enrichment agenda had on female students.

Perceptions and characterization of STEM in the media also play a significant role in the acceptance and rejection of STEM. In [36, 41] the media is accused of igniting and perpetuating negative stereotypes about STEM.

There is a stigmatization of its degree of difficulty and a reinforcement of the perception that STEM is only for the academic elite. Nevertheless, considerable portions of youth are positively influenced by the media [42, 43].

Another often cited reason for losing interest in the STEM is the absence of technology based instruction in classrooms. Often, students report that they choose other majors simply because of the meager quality of instruction they get at the college level. However, a positive contentment of a students' academic program is one of the foremost factor in attainment of degree for both major and non minor students. Research proves that as minority students identify their STEM fields as pleasant, they are likely to persist in studying those courses ignoring their complexity [44]. Researchers in [44] insist that the lack of modern technological infrastructure in the classrooms retards the growth of STEM-interested students. Active learning and positive use of technology to enhance professional developments, e. g. using online resources/mentors, computer-assisted instruction, service-learning, can help transform traditional, lectured-based pedagogy into well-received, interesting STEM classes [45-49]. A rescheduled consequence of the student's interest and commitment in his field is that it helps the faculty in teaching classes and unlocks opportunities for students to carry out research

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independently or in conjunction with the faculty [45]. In response, these experiences serve to enhance the student's fulfillment with their faculty members, majors and their general academic understanding. Among the majors in biology science, the presence of a student centered faculty is in question relating to the general fulfillment of student with the faculty and curriculum. Enhancement of satisfaction with faculty happens to follow various factors as, for instance, the anticipation that regardless of the major which the students choose. Among physical fields of system, the presence of a strong faculty research only helps to discourage students to pursue the major and to have dissatisfaction with their study program. While some researchers theorized that the finding is probably the outcome of the principal utilization of teaching educators among research faculty, a more satisfactory assumption is that the major of attention paid to scientific investigation and findings is not what the students waited for in class [47].

Financial support also plays a huge role in determining whether a student will pursue in STEM major or in non STEM major. Basically, STEM disciplines take a longer period of time to complete than other non STEM fields.

Therefore, intervention of financial aid has to be present to encourage the student to pursue in these disciplines. As such, the significance of financial aid on keeping students enrolled and interested in STEM careers or majors is clear. Adequate financial support is one of the main factors related to the perseverance of minority students in STEM disciplines [48].

The type of institution that a student attends is also of great significance when it comes to making a decision to pursue STEM disciplines . Students who attend community colleges are more probably not to major in STEM

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disciplines. From the research, it is evident that student who enroll in four year institutions are more likely to complete their STEM studies that those who attend community colleges [48].

Furthermore, researcher in [50] points to the role that gender and stereotypes play into the retention of women in STEM college programs. Researchers in [51-53] also point to the lack of women in STEM college programs due to negative stereotypes about women in STEM careers , e. g. STEM is a “ men’s only field” and “ women can’t think analytically”. Existence of negative stereotype in the society saddens student’s personal assessment skills, impacts his or her performance, and discourages the development made by them. Stereotypes impact students’ career aspirations and decisions, directing them away from degrees and careers in STEM disciplines. This can suggest that adjusting negative stereotypes about women in the STEM field by increasing the confidence of young women about their involvement in STEM may increase numbers of women successfully studying and working in STEM disciplines [50-55].

Following the lack of in-depth field research about the factors that cause UAE students to choose STEM and non STEM fields, this paper considers the starting point of a research project that aims to determine which barriers emerge as the most prominent for United Arab Emirates students, between grades 9 and 12, being switched off STEM and pursuing further education or careers in the field.

## **research Methods**

The methods of research for this project consisted of the following procedures meted out to both public and private schools. Since the United Arab Emirates is a socio-cultural collage of people originating from different nationalities, these surveys were sent to both institutional sectors, especially since the majority of expatriates attend private schools. Although differences and similarities arising among public/private schools, male/female, and Emirati/non-Emirati were compared and contrasted, the overall goal of the research, as reflected in the questionnaires, was to investigate what motivates students to pursue a STEM related education.

Students from a representative sample pool answered a questionnaire that consisted of twenty-five questions. These questions are separated into six major categories. These categories are:

Usefulness and value of STEM for students.

Effective motivation of students for STEM majors.

Students' views on STEM related careers and salaries.

External influences on students to pursue a STEM related major.

Language in which STEM