ICRES International Conference on Research in Education and Science
www.icres.net April 1-4, 2021 Antalya, TURKEY www.istes.org

Exploring Middle School Students' Interest and Their Perceptions of the Effect of STEM Education on Their Future Careers

Derar Serhan
Arizona State University, USA, https://orcid.org/0000-0003-3767-1046

Farouq Almeqdadi
Farouq ALMEQDADI - Emirates College for Advanced Education (ECAE), U.A.E.,
https://orcid.org/0000-0002-6753-5670

Abstract: This study investigated middle school students' interests and perceptions of the importance of developing their knowledge and skills in Science, Technology, Engineering and Mathematics (STEM) in the United Arab Emirates (UAE). In addition, the study also investigated the effect of gender on students' interests and perceptions. One hundred fifty-four students participated in the study. Data were collected using a survey consisting of 48 questions divided into four major categories: demographics, students' knowledge about the job market in relation to STEM, students' interest in STEM subjects, and students' perceptions of the importance of a solid knowledge of STEM on their future careers. The results indicated that all students believed that having good scientific knowledge and skills are important to get a decent job in today's market. In addition, the results of the study showed that gender was not a significant factor on students' interests in STEM; female students were more interested in learning Chemistry and Biology, while male students were more interested in learning Mathematics.

Keywords: STEM education, Students' perceptions, Gender differences

Introduction

Science, Technology, Engineering and Mathematics (STEM) education is an integral part of learning in today's economy. It incorporates educational activities across all grade levels as part of an interdisciplinary and hands-on approach to real-world applications of learning. The main goal of STEM education is to encourage students to take an interest in STEM subjects at an early age to prepare them for the job market, and in turn, benefit the greater economy (Batdi, Talan, & Semerci, 2019; Gonzalez & Kuenzi, 2012; Marick Group, 2016; Rodger, 2010). Some studies that have focused on STEM education investigated the role of gender on students' choices of STEM careers and the interest of female students in these careers (Aswad et al., 2011; Beede et al., 2011; Christensen et al., 2014; Dickson, 2010; Forgasz et al., 2014; Gnilka & Novakovic, 2017; Hebebci, 2019; Pasha

Serhan, D. & Almeqdadi, F. (2021). Exploring middle school students' interest and their perceptions of the effect of STEM education on their future careers. In M. Shelley, I. Chiang, & O. T. Ozturk (Eds.), *Proceedings of ICRES 2021-- International Conference on Research in Education and Science* (pp. 1-10), Antalya, TURKEY. ISTES Organization.

-Zaidi & Afari, 2016; Rainey et al., 2018; Riegle-Crumb & King, 2010; Vu et al., 2019).

The Program of International Student Assessment (PISA) which provides education stakeholders in the UAE with comprehensive data about teaching and learning in Science, Mathematics and Reading for 15-year-old students, found that UAE students ranked 37th in mathematics and 35th in science among 70 participating nations. The UAE was the highest performing country among Arab countries. The PISA (2015) data showed that UAE female students outperformed male students in all domains. These data allow policymakers and educators to track educational progress and growth while providing them with the information necessary to improve the performance of students, teachers and school leaders.

The UAE Government policy (2015) recognized the importance of innovation and the primary role it plays in economic progress. This is also reflected in the UAE's Vision 2021 that highlights the importance of science, technology and innovation and their role in moving the UAE towards a knowledge-based economy:

> *"Innovation, research, science and technology will form the pillars of a knowledge-based, highly productive and competitive economy, driven by entrepreneurs in a business-friendly environment where public and private sectors form effective partnerships" UAE Vision 2021*

The UAE's National Agenda 2021 set many goals to support this vision. The goals include becoming one of the top ten countries in the world in the Global Innovation Index, increasing research and development expenditure three folds by 2021, seeking to increase the share of knowledge workers to 40% of total workforce, and advancing the rank of students in mathematics, science and reading to become among the 20 highest ranked countries. STEM education in UAE was introduced by Abu Dhabi Education Council (ADEC–www.adec.ac.ae) when it revealed major changes to Abu Dhabi Schools' curriculum in March 2015 (Pennington, 2015). Consequently, these changes were implemented to fulfill the country's labor market demands.

In 2019, Soomro wrote a paper about the progress of STEM-based education in UAE. In addition to discussing needs of STEM based education, an implementation framework was proposed. He stated that "STEM should be supported by stakeholders and these are proposed as 4Ps, which includes parents, patrons, practitioners and partners." *p*. 159. He suggested the following framework:

> *students are supposed to be self-motivated; they work in collaboration with other students under teacher supervision. Student engages themselves in all sorts of discussion and inquiries and solves real world problems.*
>
> *teachers are interdisciplinary facilitators rather than lecturers and mentoring students throughout to solve real world problems.*
>
> *Parents here supposed to be closed to students and teachers and should be having regular interaction with teachers regarding performance of students. They must be very much interested in and fully*

involved with STEM activities performed at schools.

Patrons here mean the owners / CEOs of schools; they initiate STEM education and provide financial support to school. Patrons can be any Government Entity, which directly or indirectly support STEM activities at schools.

Practitioners are school teachers; academicians; STEM researchers; and STEM curriculum developers. They design curriculum in such a way so that students feel comfortable and involved in STEM related activities.

Partners are main sponsors of STEM education. They may be public or private entities, ready to cooperate and support STEM activities at schools.

In their study, Makhmasi et al. (2012) investigated 9-12 grade students' interests in STEM. One thousand 9-12 grade students participated in the study; 626 STEM-track students and 374 non-STEM track students enrolled in public and private schools across the country. The participants also included a group of university students. A questionnaire that consisted of twenty-five questions was administered. The questions were divided into six major categories: 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 courses are being taught; and Females and their role in STEM majors and careers. The findings indicated that the participants found that STEM education was useful for real life, lead to high rewarding careers For STEM majors, and that STEM fields are suitable for females.

John & Varghese (2018) conducted a study in the STEM schools of Dubai, UAE to determine the interest of students in pursuing STEM education and STEM careers. An online survey which consisted of five set of questions was conducted for students. A total of 313 students participated in the survey. The data were analyzed by using both descriptive and inferential methods including mean, standard deviation, and chi-square test. The researchers concluded that STEM students in Dubai schools have a sincere interest in STEM subjects and that the schools provided a suitable environment for STEM education.

Vu et al. (2019) examined the popularity of STEM majors among talented/gifted students and how that affected their major choices. Data from 109 students with perfect SAT and/or ACT scores in Nebraska, USA between 2011 and 2016 were collected. The researchers found that the majority of gifted students (71%) chose a STEM major when they entered colleges. Also, they found that among the four factors (school type, living location, gender, and race), gender was the only variable that contributed to gifted high school students' choices of college majors in STEM.

In their study, Gnilka and Novakovic (2017) argued that females still have less ability to choose STEM careers. To remove the barriers around STEM careers for female students, educators, parents and the broader community must collaborate to change the status-quo so more females can pursue STEM careers.

Pasha-Zaidi & Afari (2016) argued that females in UAE showed less interest in STEM subjects especially in math and science. The UAE is encouraging both genders to enter the STEM field because of the need for local engineers from both genders to fill the career vacancies in the oil industry.

This study focused on students' interests in STEM subjects and their knowledge about the impact of these subjects on their future careers. The study also focused on the role that gender plays in students' perceptions.

Purpose of the Study

The purpose of the study was to investigate students' interests in STEM subjects and their knowledge about the impact of these subjects on their future careers. The study was designed to answer the following questions:

1. How much knowledge do students' have about the job market related to STEM?
2. To what extent are students interested in STEM school subjects?
3. What are students' perceptions of the impact of having a good knowledge of STEM subjects on their future careers?
4. Is there any difference between students' interests and knowledge based on gender?

Method

The students who participated in this study were middle school students in the United Arab Emirates. One hundred fifty-four students participated in this study. Seventy-six of these students were male students and seventy-eight were female students. The majority of these students (92.2%) were 14-15 years old. Most of them (74%) indicated that they have a family member who has a STEM career. To provide answers to the research questions, data were collected using a survey that consisted of three major parts: students' knowledge about the job market related to STEM; students' interest in STEM subjects; and students' perceptions of the impact of having a good knowledge of STEM subjects on their future careers.

Results and Discussion

The first part of the study investigated students' knowledge of the job market in relation to STEM. Students were asked to respond to the question "How informed are you about these topics?" by choosing from the following answers: "not informed at all", "not well informed", "fairly informed" to "very well informed". This part was divided into four categories, each one covered a different STEM subject. The following table (Table 1) provides the percentages for the "fairly informed" and "very well-informed" responses, and will be referred to as "informed" during the discussion. As seen in the table, 60.4% of the students indicated that they were informed about science-related careers that were available in the job market in relation to Mathematics (56.5%), Engineering (59.1%) and Technology (53.3%); 57.3% of all participants indicated that they were informed of

STEM-related careers. Students indicated that among STEM subjects, the subject that they were the least informed in terms of career and employer search was Mathematics, the one they were most informed about was Engineering.

Table 1. Students' Knowledge about STEM-related Careers

Subject/Item	Very well informed	Fairly informed	Total
Science			
1. Science-related careers that are available in the job market	7.8	52.6	60.4
2. Where to find science-related careers	17.5	36.4	53.9
3. The steps students need to take if they want a science-related career	21.4	40.3	61.7
4. Employers or companies that hire people to work in science-related careers	9.1	34.4	43.5
Mathematics			
1. Mathematics-related careers that are available in the job market	20.1	36.4	56.5
2. Where to find mathematics -related careers	7.8	40.9	48.7
3. The steps students need to take if they want a mathematics -related career	11	33.8	44.8
4. Employers or companies that hire people to work in mathematics -related careers	5.8	33.8	39.6
Engineering			
1. Engineering-related careers that are available in the job market	16.9	42.2	59.1
2.Where to find engineering -related careers	14.9	41.6	56.5
3.The steps students need to take if they want an engineering-related career	14.9	41.6	56.5
4.Employers or companies that hire people to work in engineering-related careers	13	46.8	59.8
Technology			
1.Technology-related careers that are available in the job market	13	40.3	53.3
2.Where to find technology -related careers	14.3	41.6	55.9
3.The steps students need to take if they want a technology-related career	14.3	32.5	46.8
4.Employers or companies that hire people to work in technology-related careers	14.3	33.8	48.1

Table 2 provides the means for the responses provided in Table 1 for each one of the four items. The majority of students (57.3%) indicated that they were informed about STEM-related careers, only 47.8% indicated that they were informed of employers or companies that were hiring in STEM-related careers.

Table 2. Means of Students' Knowledge about STEM-related careers

	Means of Table 1 percentages
STEM-related careers that are available in the job market	57.3
Where to find STEM -related careers	53.8
The steps students need to take if they want a STEM-related career	52.5
Employers or companies that hire people to work in STEM-related careers	47.8

The second part of the study investigated students' interest in STEM subjects. Participants responded to the question "To what extent are you interested in the following school subjects?" by choosing their answer from the following "I never had this subject"," not interested"," less interested", "interested" to "highly interested" (on a scale from 1 to 5). Students who indicated that they interested and highly interested in STEM subjects ranged from 57.8%-71.5% which means that students have an interest in taking STEM classes. Students showed the most interest in Biology followed by Mathematics. They showed the least interest in Space Science and Physics (see Table 3).

Table 3. Students Interest in School Subjects

School Subject	Highly interested	Interested	Total
Mathematics	18.2	50.6	68.8
Earth Science or Geology	20.1	44.8	64.9
Chemistry	22.7	39.6	62.3
Biology	37.7	33.8	71.5
Space science or Astronomy	29.9	27.9	57.8
Physics	22.1	35.7	57.8
Applied Science or Technology	21.4	40.9	62.3

The third part of the study investigated students' perceptions of the impact of having a good knowledge of STEM on their future careers. In their responses to "How much do you agree with the following statements?" students chose from the following responses "strongly disagree", "disagree"," agree" to "strongly agree" (on a scale from 1-4).The majority of students' "agreed" or "strongly agreed" that having a good knowledge and skills in Science, Mathematics and Engineering is needed to get a good job in today's world. The percentages ranged between 80.6%-97.4% based on the subject. Students also "agreed" or "strongly agreed" that most jobs nowadays require scientific, mathematical or engineering with percentages ranging from 81.2- 87.7 based on the subject (see Table 4).

Table 4. Students' Perception of STEM Subjects knowledge on their Future Carriers

Subject	Strongly agree	Agree	Total
Science			
It is important to have good scientific knowledge and skills in order to get any good job in today's world.	59.7	37.7	97.4
Employers generally appreciate strong scientific knowledge and skills among their employees.	37	52.6	89.6
Most jobs today require some scientific knowledge and skills.	44.2	43.5	87.7
Mathematics			
It is advantage in the job market to have good mathematics knowledge and skills.	46.1	46.1	92.2
It is important to have good mathematics knowledge and skills in order to get any good job in today's world.	35.7	50.6	86.3
Employers generally appreciate strong mathematics knowledge and skills among their employees.	26	55.2	81.2
Engineering			
Most jobs today require some engineering knowledge and skills.	31.2	49.4	80.6
It is advantage in the job market to have good engineering knowledge and skills.	31.8	54.5	86.3
It is important to have good engineering knowledge and skills in order to get any good job in today's world.	31.2	50	81.2
Future Interest in STEM Subjects			
I would like to study science after secondary school	44.2	31.2	
I would like to study mathematics after secondary school	22.1	34.4	
I would like to study engineering after secondary school	26.5	32.5	

In regards to the effect of gender on students' perceptions of the impact of having a good knowledge of STEM subjects on their future careers, the means of students' responses for Table 4 were calculated. The means for male students ranged from 2.93 – 3.47, while the means for female students ranged from 2.42- 3.62. Student' means were very close for most items. It is interesting to notice that the lowest mean score for both groups was for the same item "I would like to study mathematics after secondary school" which was 2.93 for males and 2.42 for females. This finding indicates that there is more interest among male students to continue mathematical learning in the future. In addition, the highest mean score for both groups was for the same item; "It is important to have good scientific knowledge and skills in order to get any good job in today's world." The mean was 3.47 for male students and 3.62 for female students. This indicates that, regardless of gender, students believed that having a good scientific knowledge and skills is important to get any good job in today's world.

In regards to students' interests in STEM subjects, it can be seen from the Table 5, there was only a small variation between male and female students' interests in STEM subjects. Male students indicated more interest in Mathematics (a mean of 3.88 for males compared to 3.62 for females). Male students were more interested in Technology (a mean of 3.71 for males compared to 3.29 for females). Female students were more interested in Chemistry (a mean of 3.87 compared to 3.61 for males), Biology (a mean of 3.95 compared to 3.89 for males) and Physics (a mean of 3.72 compared to 3.59 for males). There was not much of a difference between students' interest in STEM subjects based on gender.

Table 5. Students' Interest in STEM Subjects Based on Gender

	Male		Female	
	Mean	SD	Mean	SD
Mathematics	3.88	.993	3.62	.871
Earth Science or Geology	3.67	1.320	3.5	1.125
Chemistry	3.61	1.108	3.87	.812
Biology	3.89	1.206	3.95	1.104
Space science or Astronomy	3.53	1.483	3.37	1.451
Physics	3.59	1.073	3.72	.966
Applied Science or Technology	3.71	1.273	3.29	1.32

Conclusion

The purpose of the study was to investigate students' interests in STEM subjects and their knowledge about the impact of these subjects on their future careers. The study was designed to investigate students' perceptions of the impact of having a good knowledge of STEM subjects on their future careers and to investigate whether gender has any effect on students' interests and knowledge about STEM subjects. Participants in this study showed interest in learning STEM subjects in the future. In particular, they showed interest in learning mathematics and science. They also indicated that it was important to have good scientific knowledge to get a good job. The findings of this study indicated that students are interested in STEM subjects. This finding can provide insight to educators and stakeholders. It is very important for stakeholders including educators and administrators to build on the findings of this study and to improve the STEM school curriculum to enhance students' knowledge and prepare them for today's careers.

References

Aswad, N.G., Vidican, G., & Samulewicz, D. (2011). Assessing the impact of socio-economic inequities on college enrolment: emerging differences in the United Arab Emirates, *Journal of Higher Education Policy and Management*, *33*, *5*, 459-471. Retrieved from DOI: 10.1080/1360080X.2011.605221

Batdi, V., Talan, T., & Semerci, C. (2019). Meta-Analytic and Meta-Thematic Analysis of STEM Education.

International Journal of Education in Mathematics, Science and Technology (IJEMST), 7(4), 382-399.

Beede, D. N., Julian, T. A., Langdon, D., McKittrick, G., Khan, B., & Doms, M. E. (2011, August 1). Women in STEM: A Gender Gap to Innovation. *Economics and Statistics Administration Issue Brief,* 04-*11*. Retrieved from https://ssrn.com/abstract=1964782 or http://dx.doi.org/10.2139/ssrn.1964782

Christensen, R., Knezek, G., & Tyler-Wood, T. (2014). Student perceptions of science, technology, engineering, and mathematics (STEM) content and careers. *Computers in Human Behavior, 34*, 173–186.

Dickson, L. (2010). Race and Gender Differences in College Major Choice. *The ANNALS of the American Academy of Political and Social Science, 627* (1), 108–124. Retrieved from https://doi.org/10.1177/0002716209348747

Forgasz, H. J., Leder, G. C., & Tan, H. (2014). Public views on the gendering of mathematics and related careers: International comparisons. *Educational Studies in Mathematics, 87*(3), 369–388.

Gnilka, P.B., & Novakovic, A. (2017), Gender Differences in STEM Students' Perfectionism, Career Search Self-Efficacy, and Perception of Career Barriers. *Journal of Counseling & Development, 95*, 56-66.

Gonzalez, H.B., & Kuenzi J. J. (2012). Science, technology, engineering, and mathematics (STEM) education: a primer. Congressional Research Service 7-5700, Washington, DC. Retrieved from http://www.stemedcoalition.org/wp-content/uploads/2010/05/STEM-Education-Primer.pdf

Hebebci, M. T. (2019). The impacts of science, technology,engineering and mathematics applications on middle school students' academic achievement, scientific creativity and attitudes. (Unpublished doctoral thesis). Necmettin Erbakan University, Konya, Turkey.

John, V., & Varghese, M. (2018), STEM: A Study in the Schools of Dubai. Proceedings of *8th International Conference on Education and eLearning* (EeL 2018), (pp. 36-42). Singapore: Global Science and Technology Forum. Retrieved from https://pdfs.semanticscholar.org/3b51/4c9e3769a3b1f9aa27676fa76f195a547f79.pdf?_ga=2.117715277.557974186.1573227141-215345704.1573227141

Makhmasi, S., Zaki,R., Barada, H. & Al-Hammadi. Y. (2012). Students' interest in STEM Education A survey from the UAE, Proceedings of *the IEEE Global Engineering Education Conference* (EDUCON). Retrieved from https://ieeexplore.ieee.org/document/6201144

Marick Group. (2016). A Look At The History Of STEM (And Why We Love It), Marick Group. Retrieved from https://www.marickgroup.com/a-look-at-the-history-of-stem-and-why-we-love-it/

Pasha-Zaidi, N., & Afari, E. (2016). Gender in STEM Education: an Exploratory Study of Student Perceptions of Math and Science Instructors in the United Arab Emirates. *International Journal of Science and Mathematics Education, 14* (7),1215-1231.

PISA (2015). Performance of 15-year-olds in the UAE: A First-Rate Education for the Future Workforce, United Arab Emirates Ministry of Education. Retrieved from https://www.moe.gov.ae/Arabic/Docs/Assessment2014/PISA/PISA2015%20Media%20Report.pdf

Rainey, K., Dancy, M., Mickelson, R., Stearns, E., & Moller, S. (2018). Race and gender differences in how sense of belonging influences decisions to major in STEM. *International Journal of STEM Education, 5*, (10). Retrieved from https://doi.org/10.1186/s40594-018-0115-6

Riegle- Crumb, C., King, B. (2010). Questioning a white male advantage in STEM: Examining disparities in

college major by gender and race/ethnicity. *Educational Researcher*, *39*(9), 656–664. Retrieved from https://doi.org/10.3102/0013189X10391657

Rodger W, B. (2010). What is STEM Education?. *Science 27*, 329, Issue 5995, pp 996. Retrieved from https://science.sciencemag.org/content/329/5995/996

Soomro, T.R. (2019). STEM Education: United Arab Emirates Perspective. Proceedings of *the 8th International Conference on Educational and Information Technology* (ICEIT), (pp. 157-160). Retrieved from https://dl.acm.org/citation.cfm?doid=3318396.3318414

UAE Government (2015). Science, Technology & Innovation Policy in the United Arab Emirates, 1st Edition. Retrieved from https://www.moei.gov.ae/en/innovation/innovation-science-technology-and-innovation-policy.aspx

Vu, P., Harshbarger, D., Crow, S., & Henderson, S. (2019). Why STEM? Factors that influence gifted students' choice of college majors. *International Journal of Technology in Education and Science (IJTES)*, *3*(2), 63-71.