Journal of Teaching and Teacher Education
ISSN (2210-1578)
J. Tea. Tea. Edu. 11, No. 2 (July-2023)

http://dx.doi.org/10.12785/jtte/110205

Gender Differences in Interactions with STEM Curricula in a K-12 School in Bahrain

Dr. Rana Oubary[1]

[1]*Middle School Principal, Senior Leadership Team, Modern Knowledge Schools, Manama, Bahrain*

Received 03 Feb 2023, revised 11 March 2023, Accepted 22 March 2023, Published 01 July 2023

Abstract: The underrepresentation of women in science, technology, engineering, and mathematics (STEM) studies and fields can have long-lasting consequences. Most studies address the underrepresentation at the college level and in the workforce, but few studies focus on the formative school years (K–12). To uncover deep-seated reasons for the disparity later, this study investigated differences between male and female students vis-à-vis achievement and interaction with the curriculum in mathematics and science classes in elementary, middle, and high school. To add to the body of knowledge about education in the Arab world, the research site was an American-based curriculum school in the Kingdom of Bahrain. This exploratory case study used the STEM classroom as the *case* and was based on the leaky STEM pipeline theory and the transformational leadership theory. Classrooms were observed, the corresponding teachers were interviewed, and corresponding documents were reviewed. The qualitative data was coded based on predetermined themes (e.g., interest, collaboration, and response to differentiated instructions), and emergent themes (e.g., content and presentation of students' work). Across grade levels, female students favored explaining facts, defining terms, writing lengthy reflections, having colorful projects, and conceptualizing scientific theories. Across grade levels, students from both genders collaborate well. Male students are more interested in science due to the tactile nature of the subject.

Keywords: STEM, K-12 Schooling, Gender Differences, Arab World, Underrepresentation.

1. Introduction

Science, technology, engineering, and mathematics (STEM) fields have allowed humankind to reach the moon, cure diseases, and have instant communications. The world needs a diverse, educated, and innovative STEM workforce to ensure a strong economy and a better quality of life (Moreno et al., 2016). The number of university students pursuing STEM degrees decreased globally, leading to a waste of talented scientists and engineers (Dejarnette, 2012). STEM industries sounded the alarm on the future of STEM professions and took initiatives to raise awareness of the STEM needs of the future (Aldemir & Kermani, 2016). The problem is amplified when women enter STEM fields at an even lower rate than men.

Women are usually less confident in STEM university courses and more likely than men to leak out of the STEM pipeline (Chan & Cheung, 2018). Globally, STEM majors and fields are strongly associated with the male gender, explaining biases in educating, hiring, and mentoring female students in STEM (Grunspan et al., 2016). The root of the problem can arise from the K–12 formative years and addressing the issue at the college level may be too late. Studying the interaction with STEM curricula and students' achievement at a younger age may uncover reasons for the dispersion later. This study took place at an American-based curriculum K–12 school in the Kingdom of Bahrain.

The purpose of this exploratory case study was to describe the interaction with curriculum and the achievement of female students and male students in science and mathematics classes, to explore the later disproportional leak of the STEM pipeline, where women are mostly affected. The study examined the lack of women in STEM through the lens of classroom performance, behaviors, and interaction with the STEM curriculum. The study targeted two science and two math classes in the elementary (Grade 5), middle (Grade 8), and high school (Grade 11) grades of a private American-

Email: Roubary@hotmail.com

based curriculum school in the Kingdom of Bahrain. Grade 5 marked the end of elementary school; Grade 8 marked the end of middle school; and Grade 11 marked the end of mandatory science and mathematics classes in high school. A total of 12 classrooms were used in the study. The five corresponding teachers were interviewed, one from elementary school teaching both math and science; two teachers from middle school, one teaching math and one teaching science; and two teachers from high school, one teaching Algebra II and teaching Physics.

This case study focused on gender differences in interactions with STEM curriculum in elementary school, middle school, and high school, at an American-based curriculum school school in the Kingdom of Bahrain. A closed system over time (i.e., a STEM classroom) was explored through data collected from multiple resources and then described in a report (Creswell, 2014). Due to the unpredictability of gender interaction with mathematics and science curricula, the exploratory case study research design was chosen for this research (Yin, 2016).

The purpose of this exploratory case study was to describe the interaction with curriculum and the achievement of female students and male students in science and mathematics classes to explore the later disproportional leak of the STEM pipeline, where women are mostly affected. The research questions were:

-Research Question One: How does gender affect Grade 5 students' interaction with the curriculum and achievement in mathematics and science (STEM) subjects?

-Research Question Two: How does gender affect Grade 8 students' interaction with the curriculum and achievement in mathematics and science (STEM) subjects?

-Research Question Three: How does gender affect Grade 11 students' interaction with the curriculum and achievement in mathematics and science (STEM) subjects?

2. THEORETICAL FRAMEWORK

This study adopted Bass's (1990) transformational leadership theory and Grogan's (2019) leaky STEM pipeline depiction. The transformational leadership theory of Bass (1990) challenges the status quo and can be applied to advocate for implementing women-friendly policies in STEM fields and changing the K–12 STEM curriculum to appeal to young females. Bass's (1990) theory focuses on followers' professional growth, and the revolutionization of perceptions and expectations. This leadership style prioritizes followers' motivation, satisfaction, and commitment to change (Yu et al., 2002). The STEM pipeline is a metaphor for the pathway that takes students through the educational system and into STEM careers (Ball et al., 2017). The leaky pipeline theory sheds light on the disproportionate loss of women along the way to a STEM degree that results in the underrepresentation of this gender in STEM careers (Grogan, 2019).

Transformational leaders can blend and use these two theories to create gender-balanced STEM studies and work fields. Transformational leaders meet the followers' standards (Bass, 1990), and women are half of these followers whose needs should be heard and acknowledged. Gender-fair organizations are needed and should be regulated by transformational leaders who challenge stereotypes and the preconceived notions of the public and stop the leak.

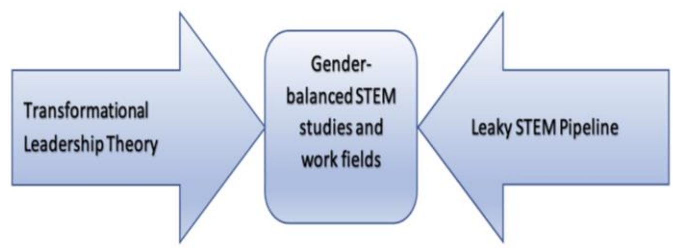

Figure 1: Blending of Two Theories

3. CONTEXTUAL BACKGROUND

The literature research represents studies done in the Western world; yet, the few studies done in the Arab world reveal an almost contradictory reality. In the Middle East, girls outperform boys in all STEM areas, yet gender discrimination is rampant (Lucas, 2017). To become an advanced nation, Arab leaders have been making bold decisions to remove the barriers of stereotypes and inherent biases and encouraging women to pursue higher education (Islam, 2019). Also, the new welcoming Arab environment encourages women to enter STEM fields (Douaihy, 2018). In the Middle East, an overwhelming majority of women are taking STEM studies seriously; for example, in the United Arab Emirates and Oman, 60% of university graduates in STEM have lately been women. In comparison, in Sweden and in the United Kingdom, only 34% and 29% respectively of STEM graduates have been women (Stoet & Geary, 2018). Women are driven by performance, and in the Arab world, women are pioneers in the workplace, breaking any preconceived notion about belonging in such fields (Merelli, 2018).

Islam (2019) argued that attributes to succeed in STEM fields (e.g., creativity, hard work, and intelligence) are gender neutral. In the Kingdom of Saudi Arabia, 57% of science graduates have been women, but only 16% of them are in the workforce (Islam, 2019). The research has suggested the issue is explained by the gender role of a woman to take care of her home and family, hindering any professional ambitions and growth (Islam, 2019), and by the presence of an abusive husband (Khazan, 2018). The paradox could be explained by the implementation of gender-segregated schools in most Arab countries. Most Arab governments have gender-segregated public schools and the research has suggested all-boys classes tend to be more loud and violent while all-girls classes are quieter and more cooperative (Atef, 2019).

Focusing on the specific context of the study, Bahrain has an oil-based economy with high freedom for investment and a strong job market. The island is in the Arabian Gulf. Hundreds of thousands of expatriates come to Bahrain for job opportunities, and some come with dependents. A breakdown of the Bahrain population and the school population by gender is needed. According to the Ministry of Information Affairs (2020), 49% of all Bahraini citizens are women, and women constitute only 38% of the total population, including expatriates. The breakdown of students by gender in the schools is reflective of the national ratios. In elementary schools, female students represent 45% of the student population, in middle schools 43%, and in high schools 47%. These numbers were provided by the schools' registration office.

4. METHODOLOGY

When the research question starts with "how" in a study where the behavior of participants cannot be manipulated, a case study design is the answer (Yin, 2014). Case studies explore phenomena that may not be evident from the first look and where more attention and observations are needed (Yazan, 2018). Studying gender differences in a limited number of mathematics and science classes can be more helpful than a school-wide or country-wide study. The narrow focus allows a deeper understanding of the whole and an analysis within the context of the phenomenon (Gerring, 2017). Following Creswell and Poth's (2018) criteria, numerous features allow the use of case study design. The case is identified to be the STEM classrooms and is a bounded system. Multiple sources of data provide a clearer picture of the difference between genders in STEM classes. The scene is set with a clear description of the classroom settings, the physical facilities, school rules, students' schedules in elementary, middle and high school, and the country's economy and culture.

This qualitative case study targeted two science and two mathematics classes (STEM) in elementary Grade 5, middle school Grade 8, and high school Grade 11 of a private American-based curriculum school in the Kingdom of Bahrain. Having different perspectives and sources of data promotes a more comprehensive understanding of the phenomenon studied, allows the capture of the complexity of real-life situations, and enhances the rigor of results (Heale & Forbes, 2013). The validity of a qualitative method lies in the involvement of the human experience and the extraction of data from multiple sources. For higher validity, data was triangulated with the use of multiple data collection tools, including teachers' interviews, students' document review, class observations, and notes. A qualitative case study was chosen because the effect of gender is a complicated matter that cannot be summarized with a yes or no type of question and has no one-size-fits-all solution (McNeal, 2013).

The exploratory case study research design was used for this research as gender interaction with mathematics and science curricula is unpredictable. The constructivist nature of the study, where a researcher is involved and can influence the data, builds the base of the case study (Yin, 2014). Working with participants through observations and interviews assures the strength of the design. The proximity of the classroom, the case, gives a rich, thick description and a true depiction of the difference, if any, in interaction with curricula between male and female students.

The sample studied was 12 classrooms including two mathematics and two science classes from Grades 5, 8, and 11 and the corresponding teachers. The school has about six classes for each subject. After consulting with the principals and the willing teachers, two classes from each grade level were chosen as the sample to be studied. Classes chosen for each subject have the same teacher. About 56 students were observed from each grade level. Five teachers participated in the study, each teacher selected two classes to be reviewed and observed, as explained in Table 1.

Table 1: Participating Classes and Teachers

Teacher	T1	T2	T3	T4	T5
Classes	4 sections of Grade 5 2 of Math 2 of Science	2 sections of Grade 8 Science	2 sections of Grade 8 Math	2 sections of Grade 11 Physics	2 sections of Grade 11 Algebra II

Firsthand data was collected from interviews with teachers, class observations, field notes, and document reviews. Students' interaction included interest, participation, and notebook organization and neatness. Teacher interviews were one-on-one interactions allowing an enhanced conversation (Milena et al., 2008). Interviews helped provide a rich explanation of how different genders interact in a classroom. To establish validity of the study, the newly developed interview questions were sent to five subject matter experts for review and feedback (Creswell, 2014). Each teacher was later given a transcript of the interview to be reviewed for accuracy, using the member checks method to increase the validity of the study. Teachers provided documents such as lesson plans, journals, notebooks, and scores to be reviewed. All identifying student information except gender was removed and excluded from the review.

Each class was observed one to two times in elementary school, middle school, and high school for prolonged engagement (Creswell, 2014), and each observation lasted for 40–45 minutes. The field notes taken during these observations included the class environment. The interaction and collaboration between male and female students were observed and evident by teachers' comments on group work. The timeline allocated for the fieldwork was one quarter of the school year.

Data was collected through teachers' interviews, science and mathematics class observations, field notes, and documents' review. Data was triangulated for higher validity. The researchers are key instruments in qualitative research with direct involvement in reviewing documents, observing behavior, and interviewing participants (Creswell, 2014).

Regarding interviews and document reviews, a pre-session took place with the teachers involved to explain the study. The interview with each teacher took place prior to observations. Teachers provided documents like students' daily work, portfolios, projects, formative and summative assessments, and notebooks, and scores. Teachers commented on students' scores and reacted to students' work to note any difference in performance between genders. All observations were non-participatory. The observer was seated away from students, resulting in no interaction with the teacher, the students, or the teaching process. No document review took place during class observations. Documents were scanned and saved to be reviewed during interviews and the data analysis process. All teachers were asked the same questions, yet based on the constructivist nature of the study, answers varied. Interviews deepened the understanding of events and took a different path to construct a new reality (Biddle & Anderson, 1986).

Teachers were notified of the nature of the class observation instrument. Observation is an emergent data collection strategy allowing the recording of events in real-time and the noting of unexpected occurrences to be explored later during post-interviews (Creswell, 2015). Creswell and Poth (2018) went further than documenting observations and interviews to strongly urging researchers to look at participants' body language, moods, and interactions. The ambiance and the environment of the case could be relevant too. The notes were descriptive and focused on interactions of students with the teacher and among each other. To capture the interaction, collaboration, and interest, male and female students were observed taking notes, following along a lesson, and participating in group activities in the mathematics or science classes. Field notes were taken during these observations.

Once data was collected, it needed to be prepared to be analyzed. Interviews were recorded with the permission of interviewees, then transcribed using Microsoft Word and reviewed by the interviewed teachers for more accuracy. Participants fixed any issues of wrong wording in answers or clarified some intended points as needed. The transcripts were printed with wide margins allowing the addition of comments and the data preparation for coding. The notes from class observations were scanned to be saved on the laptop. The observation notes were reviewed, and some reflections were added to dive beneath the surface of what was seen and heard (Glesne, 2010). The notes were read several times to make sense of a large amount of data. Using colored highlighters, observation notes and the interview transcripts were coded manually to create meaningful categories and codes (Marshall & Rossman, 2011). Guided by the research questions, potential codes (e.g., collaboration, organization, and participation of male and female students) emerged. Open-mindedness was key, as unexpected themes and patterns arose.

There is no single data analysis method to be applied for all case study designs; each case needs its own custom-made and choreographed method (Creswell & Poth, 2018). The qualitative data were coded manually based on themes that emerged. Great diligence was needed to correctly connect the meaning to the chunks of data (Atkinson, 2002). Coding the data gave meaning to the messiness and allowed patterns and relationships to emerge (Chenail, 2012). For example, interviews were coded by finding commonalities (Snyder, 2012).

Some patterns were expected, but to stay objective, a fresh unbiased approach was needed to explore the observation and interviews. The evolutionary nature of the coding process allowed the deletion or merger of codes (Atkinson, 2002). The set codes were revised or even combined into themes. Some unusual themes might appear to contradict the literature.

The data were organized by grades; an examination of the data in a grade level can reveal valuable information about gender interaction in classes. Desegregating the data by gender in each grade helped to answer the research questions and compare female students to male counterparts. Yet, examining the data across grades uncovered more information and patterns. Once patterns emerge, researchers establish visual correspondences between categories in the form of tables (Creswell & Poth, 2018). As a final step, themes of this case could be generalized and compared to published literature about gender differences in STEM classes. The exploratory nature of this research did not only describe the case but could be used to generate hypotheses for future investigation (Yin, 2016). The final results should inform any school decision about ways to move STEM classes forward in a gender-friendly way.

5. Findings

A. *Findings in Elementary School*

The data collected from this grade revealed an almost equal interest in math for both genders, but male students were more interested in science classes due to the practical aspects. Female students showed interest by going above and beyond the prompt, producing videos and more colorful work. The majority of the fifth graders preferred to collaborate within gender group, but in mixed groups genders collaborated with each other. Female students were more interactive with the curricula, they participated more, went the extra mile with work, and collaborated in groups. Yet, students' achievement was similar, grades were close, with a slight advantage for each gender here and there. The Venn diagram of Figure 2 shows the findings in the Elementary School.

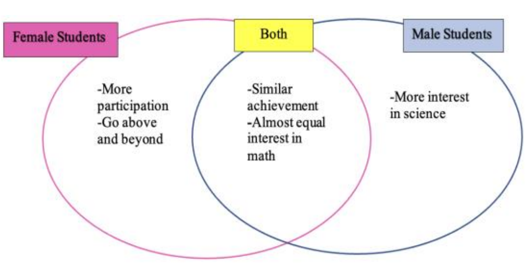

Figure 2: Males versus Female Students in Grade 5

B. *Findings for Middle School*

The data collected from this grade revealed a difference in interest between genders based on topics explained in class and the real-life examples teachers gave. Female students' interests laid in explaining scientific facts, writing mathematical definitions, and giving special attention to expressive and specific reflections. Male students were interested in numbers, tables, applications, and physics, as they were identified as tactile, visual learners. Most female students wanted to be teachers or doctors, whereas, male students wanted to be engineers or doctors. Grade 8 students mostly collaborated within gender. Female students scored slightly higher than male students, due to a deeper understanding of content, more focus, and higher interaction with the curriculum than boys. The Venn diagram of Figure 3 shows findings for middle school.

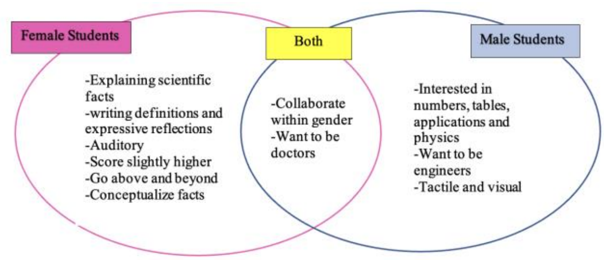

Figure 3: Males vs. Female Students in Grade 8

C. *Findings for High School*

The data collected from this grade level revealed a greater interest in Algebra II among female students with high performance, and greater interest in physics among male students, who not only had high performance like female students, but also enthusiasm and seriousness. Contradictorily, the small number of female students who were interested in physics showed extreme interest and high performance. Male students performed better in questions of solving, and female students excelled at writing reflections, explanations, and detailed analysis. Many students of both genders did not focus on the STEM content or understanding, but on scores to keep a high Grade Point Average (GPA) for university admission. Both genders collaborated across the gender line for this ultimate goal. The Venn diagram of Figure 4 shows findings for high school.

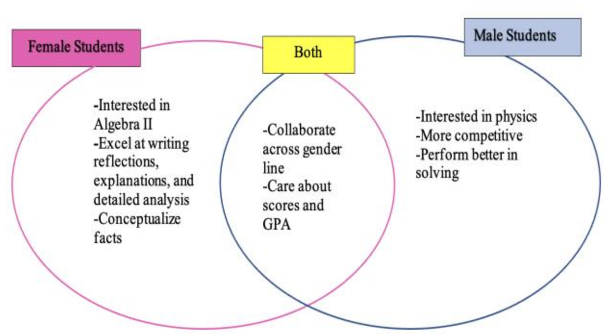

Figure 4: Males vs. Female Students in Grade 11

6. Discussion

All research questions examined interactions with curriculum and achievement in mathematics and science at the three different grade levels. Findings both conformed to and deviated from the literature. Some findings were consistent across grades and supported all three research questions.

The document reviews and teacher interviews demonstrated most female students are focused on colorful projects and lengthy reflection, which is in accord with the literature. Based on female students excelling in languages and art (Wajngurt & Sloan, 2019), the introduction of Science, Technology, Engineering, Art, and Mathematics (STEAM) at a young age had revolutionized the fields and increased the number of female students applying to any of the STEM studies. The literature pointed to elementary male students surpassing female students in math (Golsteyn & TrudieSchils, 2014). According to this study, there were no discernable differences between the two genders in elementary school. At the elementary school level, male students are more interested in science due to the tactile nature of the subject, as cited by the teacher. Male interest in physics in middle school and high school in this study is in accordance with the literature. Compared to female students with low aspirations, male students with low aspirations receive more advice and encouragement to continue studying physics from friends, family, and teachers (Mujtaba & Reiss, 2016). Even if male students lack the interest or the aspiration for physics, they were encouraged to explore these courses and careers, due to (a) an inherent gender bias, (b) a strong association of physics and engineering with the male gender (Grunspan et al., 2016), and (c) a belief in the male domination of these fields (Veelen et al., 2019).

According to the literature, female students have been more inclined to verbal fields (Sari, 2017) and excel in languages (Costantino, 2017); findings of this study were consistent with the research. Female students are more auditory, and male students are mostly tactile and visual, as indicated by interviewed teachers. The differentiated strategies and approaches to teaching and learning in both the literature and this study aligned. The study results showed female students, in all examined grade levels, leaned toward explaining facts, defining terms, and conceptualizing scientific theories. In elementary school, female students were found to be more verbal. The middle and high school teachers pointed to female students having lengthy reflections and favorability toward explaining and defining terms rather than solving problems. Female students excelling in language (Costantino, 2017) has been an established fact in the literature, but the conceptualization of math and science is not. In addition to arts, explaining STEM courses as a concept may grab female students' attention.

The decrease in the overall STEM interest among students from one grade to another was consistent with the literature. Ellis et al.'s (2016) shows how interest and participation decrease for both genders, from the fourth grade to entering the STEM workforce. The decrease is more pronounced in high school and among female students. At the research site, physics and Algebra II are high school courses required for graduation. With the exception of a small group of boys and girls whose interest was evident in their interaction in the high school physics class, the majority of students' foci was on GPA rather than knowledge itself, as recalled by the high school teachers. For true success, intrinsic motivation is needed among high school students (Matvieieva et al., 2019). At all grade levels, students from both genders collaborated well with each other, which fits with the literature: Exposure to the other gender promotes beneficial gender integration (Fabes et al., 2019). This study showed young girls feeling welcomed in STEM classes, but research had suggested adult female workers feel the threat of social identity in a male-dominated workplace (Veelen et al., 2019).

The theoretical framework for this study, discussed earlier, incorporated Bass's (1990) transformational leadership and Grogan's (2019) leaky STEM pipeline. Results of the first research question showed students in elementary school almost equal in interest and achievement, the second research question showed a seed of difference in content and presentation of students' work in middle school. The third research question addressed the high school where general interest in STEM has declined. A deeper look into the curriculum and the activities in class would shed light on what needs to be adjusted. Keeping young females interested in STEM is a task for school leaders and STEM teachers. The literature and results of this study have shown differences between the two genders concerning learning styles and the presentation of the work. Transformational leaders are needed to use humanistic qualities to adjust curricula and train teachers to address specific needs of both genders. School leaders should transform the perception and inherent biases of teachers and students so both genders are supported and encouraged to pursue any STEM study.

7. Limitations

Despite its strengths, the study also had limitations. This study involved elementary, middle, and high school classrooms—focusing on two classes from each content area in each school. Yet, the study was limited to only one private school in one country and three grade levels. The sample consisted of 12 classrooms and their five corresponding teachers. The scope of the study limited the generalizability of findings to public schools in the same country or to other private schools in Bahrain that follow a British or Canadian approach to teaching and learning. A survey or a questionnaire about students' interests, opinions, and future university plans could have made the study more student-centered.

Data were limited in time and depended on the perception and honesty of participants (Patton, 2014). The interaction with the curriculum was qualitatively described by teachers and observed in classes. Teachers' biases and individual experiences may have colored participants' answers to the interview questions and document reviews. The study was limited to the qualitative research method; a mixed-methods approach could have quantified achievement between genders. The scores of formative, summative, and cumulative assessments and of standardized tests could have been used in *t* tests.

8. Implications

This study examined data from three different divisions (i.e., elementary, middle, and high school), and contributes to expanding the body of knowledge vis-à-vis gender and STEM studies. The call for action needs to come from the top and transformational educational leaders are key to a paradigm shift in STEM education and perception. School leaders (e.g., principals, curriculum directors, heads of departments, and STEM teachers) possess power and influence over students, curriculum, and instructional practices. Changes are needed in schools to ensure opportunity is equitable for both genders. In addition to understanding child development through the K–12 years, teachers should be aware of the slight difference between genders and design activities to increase male and female engagement, interest, and performance. School leaders should conduct introductory workshops for general awareness of the subtle differences between genders, the problem of the underrepresentation of women in STEM studies and fields, and the future implications of these issues.

Integrating the arts in STEM could be the first step to get female students more interested in STEM. Crafts, language-focused activities, and drawings may attract girls' attention and initiate them into the STEM fields. Curriculum directors, with the help of principals, need to align the curriculum and train teachers on incorporating the arts in the syllabi of math and science courses. These leaders could expand knowledge of STEM careers and demystify the STEM paths for young women to increase interest in the fields. Inviting women from STEM fields as school guest speakers will show young girls a role model to follow. Organizing site visits with female employees at factories and engineering schools would show a clear connection to both the community and the STEM workforce. Similarly, hiring more female STEM teachers may encourage female students to take this path. Women can identify and connect with other female STEM experts in action that enhances other interests and confidence in STEM (Stout et al., 2011).

Because female students are drawn to language and concepts, teachers could use a differentiated teaching approach to conceptualize science facts and math theorems. In math classes, word problems help situate the question and give context to the work. Teachers need to avoid solving equations isolated from context. World problems provide authentic and meaningful real-life examples and may increase students' engagement. To demystify STEM for all genders and to increase interest among the public, an old notion of the vulgarization or popularization of science could be applied. This view means making science visible and easy to be accessed and understood by the public (Artiktay, 2020). A progressive political decision across the globe is needed to set in motion such an initiative. Scientific films, with a purpose to entertain and educate, could be concerned with empirical, methodological, and conceptual challenges associated with science communication and popularization and the public understanding of science (Vidal, 2018). Many media outlets like TV, cinema, and streaming services started this trend with the Marvel cinematic universe, Star Trek, and TV shows like The Big Bang Theory. These outlets depict men and women working in laboratories and in the STEM fields. On an anecdotal level, many STEM field workers recount growing up watching a hero, mostly from Star Trek, using science or math to solve a problem, as the reason for choosing their field of interest.

STEM fields are based on collaborative efforts among scientists from all over the world. The language of science and math is universal. According to this study, young females feel welcomed in STEM classes and students collaborate well across the gender line, yet research suggested adult female workers feel the threat of social identity in a male-dominated workplace (Veelen et al., 2019). Exposure to the other gender promotes beneficial gender integration (Fabes et al., 2019). A recommendation could be made to foster and nurture positive rapports between the two genders in the STEM classes to strengthen later collaboration.

Teachers need to focus on the importance of collaboration, group work, and team effort across the gender line to allow each gender to welcome the other and eliminate the misconception of the STEM fields being dominated by men. Examples could be given in class about scientific collaborations like the CERN supercollider in Geneva and the international space station orbiting Earth with astronauts and scientists of different races, religions, genders, and nationalities.

9. Concluding Remarks and Future Research

This study established a starting point in addressing the gap in the literature by examining the difference between genders with regard to the interaction with curriculum and achievement in STEM classes during the elementary, middle, and high school years. Research about the exploration of these differences in gender interaction and achievement in STEM classes in the Arab world has been lacking. This study begins to address the gap in the literature. Most of the existing studies addressed the leaky STEM pipe at the college level or in the workforce. Studies at the formative school years have been rarely conducted, especially in the Arab world, which is why a study of this kind is significant.

This study focused on a qualitative description of students' interactions and achievement in STEM classes. Future research is recommended based on the study finding's limitations. A quantitative comparative study of students' scores generated by standardized math and science tests and summative tests may show whether there is a significant difference between the two genders' achievement. Another study could use a survey sent to students asking about interest in STEM fields and perceived knowledge of STEM fields. Another qualitative study could have questionnaires sent to all STEM teachers of all K–12 grade levels asking about their perception of gender differences in STEM classes. Studies could also include public schools and other schools following a different approach to teaching and learning. These proposed studies can include students and teachers of all K–12 grade levels and do not have to be limited to the Kingdom of Bahrain. A similar study could be conducted in other GCC countries, Europe, or Africa.

This qualitative case study intended to explore the effect of gender on achievement and interaction with the STEM curriculum. Data collected through this case study indicated similarities and differences between the two genders. This study identified several themes. One of the overarching themes was the interest in STEM that could encompass interaction, collaboration, and performance of the two genders. Strong consideration should be given to implementing differentiated instruction in the STEM classroom to keep female students interested. Educational leaders could use the results from this study to align curriculum, restructure syllabi, and improve training for new teachers. Recommendations based on study findings include the integration of arts in the STEM curriculum, raising awareness among STEM teachers, and showcasing pioneering women in STEM. Additional research is recommended to include more grade levels, consider students' opinions, and conduct studies at different schools, including public schools.

The intention is never to advocate hiring more women than men or consider women minority hires. Meritocracy should be the basis of hiring, but women should have a fair opportunity at a decent education that does not force them to turn away from STEM. Women need a welcoming educational system, catering to their needs and not biased against gender. The paradigm is shifting!

Acknowledgment

This research would not have been possible without God as my shepherd. His love and grace enlightened my path and gave me the strength to continue. I would like to acknowledge the chairman of my school for allowing me to use her school as site of my study and the teachers who participated.

References

Aldemir, J., & Kermani, H. (2016). Integrated STEM curriculum: Improving educational outcomes for Head Start children. Early Child Development and Care, 187(11), 1–13. https://doi.org/10.1080/03004430.2016.1185102

Artiktay, G. (2020). Is the popularization of science a moral responsibility? ResearchGate. https://doi.org/10.13140/RG.2.2.11153.45925

Atef, M. (2019). *Why girls achieve academically more than boys in the Arab world? The effect of gender segregation and bullying in schools on gender achievement. University of Twente.* https://essay.utwente.nl/79413/

Atkinson, J. (2002). Four steps to analyse data from a case study method [Paper presentation]. Association for Information Systems Australasian (ACIS) conference, Barcelona, Spain. https://researchoutput.csu.edu.au/ws/portalfiles/portal

Ball, C., Huang, K. T., & Cotten, S. R. (2017). Pressurizing the STEM pipeline: An expectancy-value theory analysis of youths' STEM attitudes. Journal of Science Education and Technology, 26(4), 372–382. https://doi.org/10.1007/s10956-017-9685-1

Bass, B. (1990). From transactional to transformational leadership: Learning to share the vision. Organizational Dynamics 18(3), 19–31. https://doi.org/10.1016/0090-2616(90)90061-S

Biddle, B. J., & Anderson, D. S. (1986). Methods, knowledge, and research on teaching. In M. C. Wittrock (Ed.), Handbook of research on teaching. Macmillan.

Chan, A., & Cheung, A. (2018). Gender differences in choosing STEM subjects at secondary school and university in Hong Kong. The Women's Foundation. https://twfhk.org/system/files/stem_report_jul_3_pdf_final.pdf

Chenail, R. J. (2012). Conducting qualitative data analysis: Qualitative data analysis as a metaphoric process. Qualitative Report, 17(1), 248–253.

http://www.nova.edu/ssss/QR/QR17-1/chenail-metaphor.pdf

Costantino, T. (2017). STEAM by another name: Transdisciplinary practice in art and design education. Arts Education Policy Review, 119(2), 100–106. https://doi.org/10.1080/10632913.2017.1292973

Creswell, J. W. (2014). Research design: Qualitative, quantitative, and mixed method approaches (4th ed.). SAGE Publications.

Creswell, J. W. (2015). Educational research: Planning, conducting, and evaluating quantitative and qualitative research (5th ed.). Pearson.

Creswell, J. W., & Poth, C. (2018). Qualitative inquiry and research design: Choosing among five approaches (4th ed.). SAGE Publications.

Dejarnette, N. K. (2012). America's children: Providing early exposure to STEM. Education, 133(1), 77–84). https://projectinnovation.com/education

Douaihy, B. (2018, June 11). 4 reasons why Arab women join STEM fields & 5 challenges they face. Arabamerica. https://www.arabamerica.com/4-reasons-why-arab-women-join-stem-fields-5-challenges-they-face/

Ellis, J., Fosdick, B. K., & Rasmussen, C. (2016). Women 1.5 times more likely to leave STEM pipeline after calculus compared to men: Lack of mathematical confidence a potential culprit. PLOS ONE, 11(7), Article e0157447. https://journals.plos.org/plosone/article?id=10.1371/journal.pone.0157447

Fabes, R., Martin, C., & Hanish, L. (2019). Gender integration and the promotion of inclusive classroom climates. Journal of Educational Psychologist, 54(4), 271–285. https://doi.org/10.1080/00461520.2019.1631826

Gerring, J. (2017). Case study research: Principles and practices *(*2nd ed.). Cambridge University Press.

Glesne, C. (2010). Becoming qualitative researchers: An introduction (4th ed.). Pearson.

Golsteyn, B., & TrudieSchils, T. (2014). Gender gaps in primary school achievement: A decomposition into endowments and returns to IQ and non-cognitive factors. Economics of Education Review, 41, 176–187. https://doi.org/10.1016/j.econedurev.2014.04.001

Grogan, K. E. (2019). How the entire scientific community can confront gender bias in the workplace. Nature Ecology & Evolution, 3(1), 3–6. https://www.nature.com/articles/s41559-018-0747-4.pdf?proof=trueIn%EF%BB%BF

Grunspan, D., Eddy, S., Brownell, S., Wiggins, B., Crowe, A., & Goodreau, S. (2016). Males under-estimate academic performance of their female peers in undergraduate biology classrooms. PLOS ONE, 11(2), Article e0148405. https://doi.org/10.1371/journal.pone.0148405

Heale, R., & Forbes, D. (2013). Understanding triangulation in research. Evidence Based Nursing, 16(4), 98–98. https://doi.org/10.1136/eb-2013-101494

Khazan, O. (2018, February 18). The more gender equality, the fewer women in STEM. The Atlantic. https://www.theatlantic.com/science/archive/2018/02/the-more-genderequality-the-fewer-women-in-stem/553592/

Lucas, S. (2017, October 5). Why do Middle Eastern women pursue STEM careers at a higher rate than American women? Inc. https://www.inc.com/suzanne-lucas/if-you-want-more-women-in-tech-try-discriminating-against-them.html

Marshall, C., & Rossman, G. B. (2011). Designing qualitative research (5th ed.). SAGE Publications.

Matvieieva, O., Ovcharenko, N., Korchagina, A., Kuznetsova, O., & Grineva, V. (2019). Study of aspects facilitating «lifelong learning» competence development in high school students. *Romanian Journal for Multidimensional*, 11(2), 180–197. https://doi.org/10.18662/rrem/124

McNeal, L. A. (2013). Women in the integrated circuit: A study examining the intersection between technology, subjectivity, and the academy [Doctoral Dissertation, Appalachian State University]. NC DOCKS. https://libres.uncg.edu/ir/asu/f/McNeal%20Lisa_2013_Dissertation.pdf

Milena, Z. R., Dianora, G., & Alin, S. (2008). Qualitative research methods: A comparison between focus-group and in-depth interview. Annals of the Faculty of Economics, 4(1), 1279–1283. https://econpapers.repec.org/article/orajournl/v_3a4_3ay_3a2008_3ai_3a1_3ap_3a1279-1283.htm

Ministry of Information Affairs. (2020). Population and demographics. Retrieved on February 10th, 2021, from https://www.mia.gov.bh/kingdom-of-bahrain/population-and-demographics/?lang=en

Moreno, N., Tharp, B., Vogt, G., Newell, A., & Burnett, C. (2016). Preparing students for middle school through after-school STEM activities. *Journal of Science Education and Technology*, 25(6), 889–897. https://doi.org/10.1007/s10956-016-9643-3

Mujtaba, T., & Reiss, M. J. (2016). I fall asleep in class . . . but physics is fascinating: The use of large-scale longitudinal data to explore the educational experiences of aspiring girls in mathematics and physics. Canadian Journal of STEM, 16(4), 313–330. https://doi.org/10.1080/14926156.2016.1235743

North Carolina State Board of Education. (2013, August). North Carolina Department of Public Instruction STEM attribute implementation rubric: High school. https://www.ncsmt.org/wp-content/uploads/2013/09/STEMAttributesRubric_HIGH_v4_Aug2013_v1.pdf

Patton, M. Q. (2014). Qualitative research & evaluation methods (3rd ed.). SAGE Publications. https://aulasvirtuales.files.wordpress.com/2014/02/qualitative-research-evaluation-methods-by-michael-patton.pdf

Sari, M. (2017). Teachers' views on co-education: Co-education or single-sex education? Acta Didactica Napocensia, 10(3), 35–44. https://files.eric.ed.gov/fulltext/EJ1160564.pdf

Stoet, G., & Geary, D. (2018). The gender-equality paradox in science, technology, engineering, and mathematics education. Psychological Science, 29(4), 581–593. https://doi.org/10.1177/0956797617741719

Stout, J. G., Dasgupta, N., Hunsinger, M., & McManus, M. A. (2011). STEMing the tide: Using in group experts to inoculate women's self-concept in science, technology, engineering, and mathematics (STEM). *Journal of Personality and Social Psychology, 100*(2), 255–270. https://doi.org/10.1037/a0021385

Veelen, R., Derks, B., & Endedijk, M. (2019). Double trouble: How being outnumbered and negatively stereotyped threatens career outcomes of women in STEM. Frontiers in Psychology, 10, Article 150. https://doi.org/10.3389/fpsyg.2019.00150

Vidal, F. (2018). Introduction: From "The popularization of science through film" to "the public understanding of science." Science in Context, 31(1), 1–14. https://doi.org/10.1017/S026988971800008X

Wajngurt, C., & Sloan, P. J. (2019). Overcoming gender bias in STEM: The effect of adding the arts (STEAM). InSight: A Journal of Scholarly Teaching, 14, 13–28. https://insightjournal.park.edu/wp-content/uploads/2020/01/1-Wajngurt-and-Sloan.pdf

The White House. (2020, March 8). Remarks by President Biden on International Women's Day. https://www.whitehouse.gov/briefing-room/speeches-remarks/2021/03/08/remarks-by- president-biden-on-international-womens-day/

Yazan, B. (2018). Three approaches to case study methods in education: Yin, Merriam, and Stake. The Qualitative Report, 20(2), 134–152. https://nsuworks.nova.edu/tqr/vol20/iss2/12

Yin, R. K. (2014). Case study research: Design and methods (5th ed.). SAGE Publications.

Yin, R. K. (2016). Qualitative research from start to finish. (2nd ed.). The Guilford Press.