A SCOPING REVIEW ON OUT-OF-SCHOOL STEM PROGRAMS FOR MIDDLE SCHOOL GIRLS IN THE UNITED STATES

A Thesis

by

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ABSTRACT

Science, Technology, Engineering and Math (STEM) education is growing as an imperative 21st century academic emphasis for the development and welfare of the United States. Literature in the discipline of STEM education offer evidence showing the underrepresentation of women in STEM education and STEM careers. This underrepresentation is traced back to young girls losing interest in STEM during middle school and eventually not choosing STEM related professional opportunities as women. However, all these meaningful discourses often overshadow one critical question which is, what measures are in place to promote interest in STEM education among young girls?

In this regard, Out of School Time (OST) programs may be an effective strategy in stimulating interest in STEM education. Therefore, the purpose of this scoping review is to report and analyze a range of OST STEM programs available for middle school girls. Used in this review, scoping review as a mapping methodological framework grants the flexibility of covering a broad research area such as OST STEM programs, which has not been comprehensively studied. Additionally, this framework allows inclusion of programs reported in studies with different methodological design, as well as the ongoing research. Moreover, I have used matrix method outlined by Garrard to manage and synthesize programs reported in published studies between 2002-2018 that matched the inclusion and exclusion criteria. Forty-six programs met the inclusion criteria for this review. These reported studies are from four primary databases of education and engineering; ERIC (EBSCOhost), Education Source, Academic Ultimate, and Compendex Village. Five major themes regarding OST STEM programs emerged from the findings: 1) engineering as the main focus in the OST STEM program 2) neglecting self-identity of middle school females 3) the need for more female role models 4) insufficient OST STEM programs to meet identified needs, and 5) lack of accessibility to OST STEM programs by young women of color. This review highlights the state of current out-of-school STEM programs for middle school girls providing an opportunity for practitioners and policy makers to improve any specific characteristics of the OST STEM program.

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1. INTRODUCTION

Knowledge in Science, Technology, Mathematics, and Engineering, under the acronym STEM, is a critical 21st century skill and is widely discussed at education, industrial workforce, and policy debates in US (Gonzalez & Kuenzi, 2012). The developing emphasis on STEM flows from its economic utility, lucrative position of innovation and technical skills in the global market resulting in high paying STEM jobs (De Philipps, 2016). Moreover, this notion is consistent with *Prepare and Inspire Report*, where STEM is also seen as a determinant for wealth and success of the United States as a nation, as well as a world leader in the fields of energy, health, environmental protection, and national security (Holdren et al., 2010). Likewise, Dubetz & Wilson (2013) provide a distinct, yet compelling, rationale for STEM education which focuses on developing a population with an understanding of scientific principles, problem solving, interpreting information, and application of scientific knowledge for making sound socio-scientific decisions.

STEM as an acronym was coined by National Science Foundation (NSF) in the 1990s as a broad term to describe the program, policy, and practices related to disciplines such as; Science, Technology. Engineering and Mathematics (Bybee, 2010). Since then, STEM as an acronym has been widely used by the public. Although, the acronym is coined in the recent decades, the significance of STEM in education and national prosperity dates back to the Sputnik era of 1950's which led to the boom in STEM industry (Stevenson, 2014). And, over the years, federal policies and programs on STEM has shaped the nature of STEM education in educational institutions.

1.1 Defining STEM

The growing momentum around STEM education has gained centrality among policy makers, stakeholders, and industries sparking the promotion of STEM in teacher education programs, educational curriculum, and workforce. Yet, STEM remains just an acronym for the disciplines it represents without a definite concept or a purpose.

While scholars have acknowledged the value of STEM education in United States there is no consensus on defining STEM education, making it a subject of conflicting views (Means et al., 2016). First, research on the conception of STEM in education provides an educational perspective of STEM as "viewing the separate discipline of science, technology, engineering, and mathematics as one unit, thus teaching the integrated discipline as one cohesive entity" (Briener & Harkness, 2012, pg. 4). Second, according to Rodger W. Bybee, previously a chair on the Science Expert Group for the International Student Assessment Program, "a true STEM education should increase students' understanding of how things work and improve their use of technologies" (Bybee, 2010, pg. 996). Third, the Milwaukee based public policy forum's report on *Preparing the Future Workforce* reports that, "STEM disciplines teach important critical thinking and problem-solving skills as well as content knowledge" (Dickman et.al, 2009, pg. 6).

It is interesting to note that these multiple perspectives on STEM education come out of different contexts. For instance, the idea on STEM education by (Briener & Harkness, 2012) is based on the policy perspective which proposes an integrated approach of traditional disciplines in a K-12 educational setting. Bybee (2010) emphasizes on improving technologies, because Bybee's views emerges from a context in which engineering is seen as an approach to address problem solving, innovation and a critical 21st century skill (Bybee,2010). The public policy forum's report on *Preparing the Future Workforce* perspective on STEM is "driven by the need for middle – and high-skill workers with STEM backgrounds" (Dickman et.al, 2009, pg. 6). Therefore, the research finding by Briener & Harkness (2012) indicate that there is no uniform functional definition of STEM because people articulate STEM based on their personal experiences, work, and perspectives.

1.2 STEM policies

Literature suggests that STEM emerged out of government policy, specifically from within the National Science Foundation (Briener & Harkness, 2012). The National Science Board recommendation, Congressional Research Service Report, 2008, Prepare and Inspire, and Congressional Research Service Report, 2012 among others have been critical in deciding the STEM educational policies and instruction (Beering,2009; Kuenzi,2008; Gonzalez&Kuenzi,2012). Additionally, these reports have shaped the STEM education and instructions. For instance, in 2009, the National Science Board proposed a set of recommendation to the then President-Elect Obama. This report emphasized the critical role of STEM education and provided key recommendations and actions for the advancement of STEM based education as a pre-requisite for a technology based national economy. Here, I would like to highlight only the principal recommendations for the progress in the STEM fields made by National Science Board (Beering, 2009) because the recommendations do not focus on a unified STEM. The following are the recommendations:

- A motivated public, students, and their parents
- Clear educational goals and assessment
- High quality teachers

- World-class resources and assistance for teachers
- An early start in science
- Communication, coordination, and collaboration

Although, the recommendation focuses on the early start of science it does not represent other disciplines of STEM.

For the purposes of this review, I am using STEM education as a transdisciplinary approach across the field of science, technology, engineering, and mathematics paired with; creative and critical thinking, real-world challenges, technical and innovation skills, and problem-based learning across all degree levels ranging from pre-K- post doctorate in a formal and informal educational context (Capraro &Han, 2014; Gonzalez & Kuenzi, 2012; Siekmann &Korbel, 2016).

1.3 Under the critical lens

There is no denying that STEM education is gaining widespread popularity. However, certain aspects of STEM and related initiatives are under a critical lens. In this section, I am discussing some major issues associated with STEM education which have consistently surfaced in public forums. One of the primary concerns is expressed by D.L. Zeidler et.al (2016) critiquing the largely accepted “ideal partnership between engineering and science curriculum” in schools, which has been fiercely propagated in STEM education. This “ideal partnership” has been promoted by STEM proponents as:

“increasing the recognition of engineering in K-12 education…engineering has some presence in our schools, but certainly not the amount consistent with its careers and contributions to society” (Bybee, 2010, pg. 30)

Inclusion of engineering concepts and practices in the science curriculum is evolving as a serious concern among educators because the focus on engineering represents the school as primarily a job recruiter for a specific field, overshadowing the actual purpose of schooling. Additionally, the overemphasis on engineering devalues basic science and the nature of science concepts (Clough &Olson, 2016). This concern is one of the many challenges associated with STEM education.

Another challenge associated with STEM are the two common narratives which fueled the STEM popularity in America, students’ low performance in science and math and the shortage of STEM workforce (Stevenson, 2014). In the paper, Stevenson (2014) attempts to debunk these myths and insists that industries in manipulate the narrative to the hire foreign workers at lower wages. The lack of data to support this claim undermines its value. However, this claim by Stevenson provides a fresh perspective on STEM and related initiatives in education, industry, and federal policy.

Underrepresentation of women and minorities is the widely discussed challenge in STEM education and is a growing concern among the academicians and policy makers. Despite the efforts to diversify STEM, a small number of women are choosing these careers. According to the recent report by economic cooperation and development (OECD), only 5% of girls envision themselves in STEM related careers, compared to 18% boys, although 16% of girls are more inclined towards career in healthcare in comparison to 7% of boys (Ward, et al. 2015). The limited number of women in STEM majors affects the society at large; it fails to take advantage of a potentially talented pool of workers and of the diverse perspective women would bring into the advancement of STEM (Milgram, 2011).

According to the data by National Assessment of Educational Progress there is still a "science education achievement gap" that affects ethnic groups as well as genders. This gap is higher in Black and Latino/a student's (Parker, 2013). This achievement gap and the gross underrepresentation of women of color in STEM is affected by prior experiences, curiosity, and a sense to fit in the community. Early support to build up interest in STEM is not available to the girls of color; therefore, they develop a "anti-STEM identity" (Pinkard, et al. 2017).

These multiple concerns related to STEM education are equally important and warrant further research. However, the consistent theme of this review is to report and analyze the explore the out-of- School STEM programs for the middle school female students.

2. HISTORICAL DEVELOPMENT OF MIDDLE SCHOOLS

In America, public education is based on a three-tier system, as the name goes middle schools are the middle tier of the educational system including middle grades such as 5-8, 6-8, or 7-8 (McEwin & Greene, 2011). The birth of Middle School movement is credited to USA in the early 20th century. This movement can be viewed in four phases. It emerged in the 1960's with an aim to meet the teaching and learning needs of young adolescents; In the1980's the middle school movement was focused on developmentally responsive programs and policies, this phase also led to the increase in number of middle schools. By the 1990's middle school was gaining popularity leading to structural development with an emphasis on middle school practices, curriculum dilemma, and teacher's certification. In the new millennium of 2000, middle schools are strengthened by research-based models along with attention on groups with special needs (Schaefer et.al, 2016). Prior to the Middle School movement, the notion of puberty in USA was a transition from childhood to adulthood. However, with the evolution of middle schools, puberty was extended to adolescences as a developmental phase for sexual maturity (Dinham & Rowe, 2008). This acceptance of adolescence as a developmental phase shift the waves towards addressing the cognitive, social, and emotional needs of young adolescents.

3. ADOLESCENCE AND MIDDLE SCHOOL GIRLS

Adolescence is a developmental stage which marks the progression from childhood to adulthood and is characterized with social and biological changes. Additionally, adolescence also witnesses the grade transition in schools and cognitive development (Choudhury et.al, 2006; Wigfield et.al, 1991). According to a study “development science has focused on adolescence as a time of risk” due to the complex relationship of developmental and social changes in an individual (Eccles et.al, 1993, pg.90). Research indicates that some young individuals undergo academic failure during adolescence, the transition to junior high school is reported as the possible reason associated with the low academic achievement (Eccles et.al, 1993).

3.1 Relationship of middle school girls with STEM

The support of STEM and the ongoing technological revolution has led STEM to significant funding at the federal level. In 2012, federal agencies dedicated an impressive amount of $ 2.8 billion - $3.4 billion annual funding towards STEM education programs (Gonzalez & Kuenzi, 2012). Despite the growing resources, legislations, and funding on STEM programs, STEM education in United States indicates a grim picture for young girls as they drastically lose interest in STEM education during their transition from elementary to middle school, restricting their accessibility to professional opportunities in STEM related industries (Kuenzi, 2008; Holdren et al, 2010; Dare & Roehrig, 2016).

According to *Congressional Research Report* this limited movement of middle school girls to STEM opportunities is interconnected to a wide achievement gap based on gender among 4^{th}- 8^{th} graders (Kuenzi &Gonzalez, 2012). In the early grades, young girls perform equivalent to their male peers; however, girls' score decline on the standardize math and science tests in comparison to the male students as the girls move to the higher grades (Dubetz & Wilson, 2013; Tan.et al, 2013). Additionally, research evidence overwhelmingly shows that the majority of young students have a positive outlook towards science at the age of 10, but, this outlook starts dropping for girls by the age 14, therefore negatively shaping their attitudes towards STEM education (Dare & Roehrig, 2016; VanLeuvan, 2004). Moreover, studies indicate that while male interest in STEM remained constant (39.5% - 39.7%) in the school years, the interest of females in STEM dropped from 15.7% to 12.7%; between middle and high school (Demetry & Sontgerath, 2017; Cooper, et.al, 2013).

For young girls, middle school is seen as a critical time to maintain their interest in STEM fields. This stress on middle school is not a recent development, rather studies in the past have reported middle school as a sensitive and crucial point influencing young girls' decisions related to STEM majors (Smith, 2009). And the implication of this gender differences in STEM interest at this young age can be viewed in the way children are treated, schooled, and motivated for future career paths (Reilly et al., 2015).

3.2 Why are middle school girls losing interest in STEM?

Several scholars have discussed the downturn of middle school girls' interest and achievement in STEM education and have listed the possible reasons as 1) Cultural norms and stereotypes 2) Self-identity development 3) Science identity formation 4) Gender construction of science

Cultural norms and stereotypes: Historically and culturally, the prevalence of patriarchy in institutions such as family, church, and schools have restricted girls to their traditional roles by curbing their ambition, thoughts, and behavior making them unassertive and docile (Holloway & LeCompte, 2001). Since, science identity of girls clashes with their cultural roles, girls do not accept themselves “becoming scientists” or “doing science” (Archer et al., 2010). Additionally, stereotypes related to sex roles within the family where boys are motivated to play challenging games/toys while girls are asked to play safe promotes subtle notion indicating that girls are not as efficient, creative or adventurous as boys (VanLeuvan,2004). Moreover, stereotypes are not only gendered but inflect into race and ethnicity, African American girls with an interest in STEM major are classified as “acting white” or are viewed to have less intellect to pursue STEM (McPherson, 2017).

Self-identity development - The formative year of adolescents has a remarkable impact on young girls’ lives as they “transition to adulthood” and start developing their self-identity as well as try to place themselves in their social environment (Edwards,1996). While girls are exploring and constructing their self-identities at this age, they are also simultaneously envisioning their future goals (Smith, 2009). Absence of support from family and school marks early adolescences as a stressful period for girls as they receive cultural messages regarding their new traditionally rigid feminine role leading to loss of self-confidence and academic achievement (Holloway & LeCompte, 2001). The expectation from young girls to adopt a gender appropriate role and responsibilities different from their male peers furthermore contributes in their low self-efficacy and motivation.

Science identity formation- Science identity is defined as demonstrating science activities in order to acquire relevance and acceptance by the community as a person capable of doing science; for a young girl, science identity is under the purview of classroom setting with teachers and peers (Brickhouse et al., 2000). Research supports that social structures and identities shape the way children engage in science, while young girls in middle school are forming their own identity within the strict social gender roles, they struggle to identify themselves with science and technology, and this struggle drifts them away from developing their science identity (Archer et.al, 2010). This conflict between self-identity and the science identity formation prevents girls from adopting a science identity irrespective of their good performance in science and math (Tan et.al, 2013).

Gender construction of science- A masculine and powerful image of science has predominated for centuries and scientists have always been portrayed as masculine and Caucasian, this stereotypical gendered image has undermined middle school girls' self-efficacy and career choices (Smith, 2009; Brickhouse et al., 2000). For these young girls the masculine image of science is inconsistent with their idea of femininity, which they perceive as culturally appropriate and socially acceptable (Archer et al., 2010).

Moreover, literature suggests that a lack of support, guidance and a conducive learning environment have long term effects on the self-identity, behavior, and future choices of adolescents (Bennett & Irvin, 1996). Unfortunately, adolescent girls in middle school face various challenges, however, these challenges are not limited to academic stereotypes, as discussed above. According to Mendez et. al (2006) "investigations into the lives of girls in the early adolescents' years continue to reveal that many girls face some significant gender- related stressors as they transition from childhood to adolescence" (pg.13) which negatively impacts their growth and development. Mendez et.al (2006) have categorized these stressors into 1)

“Body image concerns and disordered eating” 2) Sexual harassment, and 3) Relational aggression

Body image concerns and disordered eating: Social media and internet has set an unrealistic beauty standard which revolves around being thin, white, and flawless. This idea of beauty has sparked body shaming and appearance dissatisfaction among young adolescents, especially in young adolescent girls resulting in socio-cultural pressure to look perfect. According to Phelps et.al (2000) survey report “over one-third of the adolescent female population report participation in such aggressive methods of weight control/ reduction as chronic dieting, excessive exercise, self-induced vomiting, and abuse of laxatives, diet medications, and water pills” (pg.450). These young girls cited media, fashion industry, and peer pressure as primary reasons for wanting a thin ideal body, additionally, they also associated thin body with self-confidence for personal success (Tiggemann,2000). Based on these evidences, it can be said that young girls deal with immense socio-cultural pressure to live up to the unrealistic beauty standard disengaging them from their academic growth.

Sexual harassment: Sexual harassment induces severe trauma and stigma disrupting social functioning, psychological and cognitive development. Moreover, it instigates anxiety, depression, eating disorders, low self-esteem and poor social relationships (Trickett et.al, 2011). A report “Hostile Hallways” published by American Association of University Women (2001) indicate that “eight in 10 students experience some form of sexual harassment at some time during their school lives” (pg.3). The AAUW report shows that sexual harassment in school significantly impacts the education of girls and boys (Lipson, 2001). Another report suggests that

40% of the sexual harassment victims who reported their case were skipping classes or were absent from school (Fogarty,2012).

Relational aggression: Relational aggression is a dimension of social bullying with a set of concealed verbal or non-verbal behavior such as spreading rumors or blocking someone from a peer group which threatens social status or involves undermining close relationships (Stuart-Cassel et.al, 2013; Mendez et.al, 2006). According to Prinstein et.al (2001) “relational aggression is as prevalent among girls as boys and appears to uniquely contribute to children’s concurrent and future social-psychological maladjustment for both sexes” (pg.479). Additionally, social bullying is prevalent among middle school youth between grades 3-8. According to a large survey 41-48 percent of girls identified themselves as victims of social bullying (Stuart-Cassel et.al, 2013).

It is important to recognize that these stressors along with the academic and socio-cultural stereotyping adversely affect a large number of adolescent girls disengaging them from learning and effecting their cognitive, psycho-social, and emotional development

4. SINGLE SEX PROGRAM

There is a growing concern over the sex difference in science and mathematics achievement suggesting male students as high achievers in comparison to their female peers: there is evidence pointing towards the widening sex difference in achievement during middle school because of the sociocultural stereotyping and the learning environment (Reilly et.al, 2015). Socio cultural stereotyping and male dominant culture in coeducational classrooms have situated girls in an unfavorable learning position therefore sparking the debate for single sex education (Johnson, 2012).

In this regard, single sex education programs have been widely promoted and implemented in order to recruit and engage more women in STEM related majors and careers. As per to the report “Separated by Sex”, middle school girls are more likely to choose single sex classroom than a coed classroom, “There is enough discomfort with what is happening in (coed) classes to a significant proportion of girls, that they prefer to leave” moreover, “some girls see the class as a refuge from boys’ intimidation” (Morse,1998, pg. 8). Data presents that single sex classroom positively shapes middle school girl’s attitudes towards science as compared to the coed classroom (Johnson, 2012). Although, research in the field of single sex education is narrow, yet the preliminary findings suggest that “single sex schooling or single-sex programs within co-educational environments are a potentially effective solution to help promote women’s engagement in STEM fields despite the sexism they face in those field” (pg.733) and this finding is attributed to the “social support” and “sense of belonging” in a single sex program. (Rosenthal et.al, 2011).

5. OUT OF SCHOOL TIME PROGRAM

The rise of STEM related careers in the global economy is rapidly changing the educational landscape of United States. Although the demand of STEM education is enormous, documented evidence overwhelmingly shows that the conventional classroom learning is not sufficient to accommodate the need for lifelong STEM learning (Afterschool Alert, 2010). Because the *Congressional Research Service Report* suggests, a worrisome number of teachers in United States teaching middle school math and science do not possess an applicable undergraduate degree in their teaching fields leading to low achievement by middle grade students, especially girls, in STEM classes (Kuenzi, 2008).

Likewise, a large number of school districts lack resources or are struggling to maintain infrastructures to support science learning in middle schools, with minimum funds from state, schools are working closely with external agencies to improve science education (*Lost Opportunities; The Status of Science Education in California Middle Schools, 2012.* Therefore, out- of-school time (OST) programs are rapidly becoming a major feature of a students' holistic development, today about 6.5 million students are engaged in OST programs throughout America fostering a positive relationship with peers and staff as well as creating a safe environment for academic growth and personal development (Grossman et.al, 2009).

An OST program such as after-school program or summer school operate before or after regular school hours, weekends, summer break or alternative holidays and provides engaging activities for life skills, experiential learning, exploring interest, recreation and building positive relationship with the community (Loosli,2000).

According to a study, the implementation of No Child Left behind (NCLB) Act, has added a new dimension in the OST programs "children in schools that fail to help all children reach proficiency are eligible to receive supplemental educational service, these services must occur outside the school day and be backed by evidence that the services are effective in raising student achievement" (Lauer et.al, 2006, pg.275). Literature on afterschool programs also suggest that students' learning is not limited to classroom hours, learning happens in out of school time as well, in this case afterschool -programs are a safe learning environment for adolescents of all background to explore their interest in STEM (Fadigan & Hammrich, 2004; Koch et.al, 2012).

5.1 Impact of OST STEM programs

Given these issues, Out -of -School Time (OST) STEM programs are growing as fertile ground to cultivate and foster interest in young middle school students, especially female students who are in a vulnerable age and are highly susceptible to losing interest in STEM education during their transition from middle school to high school (Afterschool Alert, 2010). In this light, out of school time is viewed as a potential setting for connecting school learning with afterschool experiential learning in STEM through hands on activities, piquing students' interest in STEM (Afterschool Alert, 2006).

According to Wood et.al (2012) the effectiveness of an afterschool science program for female students' interest in science careers indicate that "providing participants opportunities of authentic environmental experience such as outdoor and indoor lab opportunities, simulation, trips, and experiments, yields significant improvement in the BUGS participants' science achievement" (pg.52); supporting the argument that OST STEM programs are effective in positively influencing girls' attitudes towards science. Similarly, another metanalysis report on the effects of OST programs confirms the conclusive effect on the participants academic achievement in mathematics and reading providing further evidence towards the positive impact of OST programs. (Lauer et.al, 2006).

5.2 OST programs in a historical context

The historical development of OST programs dates back to 18th century when local institutes such as-churches, libraries, and museums were assigned to public education, specifically catering to the needs of children from low socio-economic households with poor academic records, the purpose of OST programs was to provide supplemental education in order to create opportunities for students at risk of academic failure (Lauer et.al, 2006; National Research Council, 2015).

According to Halpern (2002), "boys 'clubs" in the neighborhood or in the church were the earliest version of after-school programs during nineteenth century, these clubs came into existence primarily for two social reasons; the expanding schooling system supported by educational laws, and the downturn of child labor in America. Interestingly, the purpose of summer schools in its evolutionary phase was the "prevention of delinquent behavior", gradually the purpose was broadened to accommodate skills such as; positive relationship towards self and learning, and address learning disorder through extracurricular activities (Cooper et.al,2000).

5.3 OST STEM models

Bevan and Michalchik (2013) present two foundational models of OST programs;

Expanded learning-is based on academic content and activities to cultivate essential skills in children to enhance their participation in social life and academic context. The majority of programs based on expanded learning model are focused on mathematics and learning, however, steps are taken to integrate STEM specific programs under expanded learning. Expanded learning draws its principles from additive learning model which revolves around the premises that providing STEM intensive OST programs and opportunities will allow the children to explore their interest in science, therefore, enhancing participation in school science.

Extended learning- is basically the extension of school curriculum into OST programs. In this model, the school and OST programs work closely on a student's academic achievement which is evaluated by grades and standardized test scores. Extended learning addresses school curriculum's subject matter content and reemphasizes on school's theoretical concepts and practices.

Although, both types of model are popular among STEM educators and policy makers, expanded learning is under review due to the limitations posed by additive learning: 1) the lack of connection between school science and OST programs 2) the assumption of additive learning style which suggests that students in the OST program will positively respond towards science learning, 3) the evaluation of OST programs in additive learning is based on a student's academic performance in school science. However, additive learning fails to consider the possibility of a student's growing interest towards science or other skills like positive relationship with self and peers (Bevan & Michalchik, 2013).

After-school programs have played a vital role in impacting students' life through building capacity in youths, providing opportunities for academic performance, as well as fostering social and emotional development. Since, OST STEM programs are emerging as an alternative method to support the traditional learning in school, I aim to review the OST STEM programs with the following objectives.

6. OBJECTIVE OF THE STUDY

The objective of this review is a) to systematically report the OST STEM programs for middle school female students in the United States, b) critically analyze the OST STEM programs on the following variables: population served, size, program outcome, activity design, funding level and source, program duration, geographical location, and instructional language, and c) provide recommendation for developing future OST STEM programs. These objectives are guided by two research questions:

1) What are the available OST STEM programs for middle school female students in the US?

2) What are the main characteristics of an OST STEM programs in the US?

6.1 Rationale for the study

Research supports that young middle school girls are losing interest in STEM education which will eventually lead them not to choose STEM education and related careers (Smith, 2009). This has led to a growing anxiety around the lack of gender diversity in STEM education (Holdren et al., 2010). However, all this meaningful discourse often overshadows one critical question which is, what measures are in place to promote interest in STEM among young girls?

According to a 2012 report, there are an estimated105 to 252 type of federal STEM education programs with three primary objectives: encouraging young girls to attaining STEM degrees, research on STEM, and transition to a STEM related career (Gonzalez & Kuenzi,2012). Yet, there has been no extensive study quantifying these estimated 105-252 type of federal OST

STEM programs. Similarly, many of the OST programs have been created by educational institutions, states, local agencies and non-profit organizations have not been evaluated. This review intends to fill the gaps by studying all publicly promoted OST STEM programs aimed at middle school girls. This exhaustive nature of the review will provide an opportunity to understand the trends, developments, and approaches undertaken to address the negative attitude of middle school female students towards STEM education.

Furthermore, findings suggested by Young et al. (2017), on the effectiveness of OST programs indicate the positive influence of OST STEM program on maintaining students' interest in STEM education and related careers. However, the findings also emphasize the need for policy makers to provide equal access and opportunity for students from different geographical and socioeconomic backgrounds, suggesting that students from diverse backgrounds lack STEM opportunities.

To fill the gap suggested by Young et al. (2017), this review examines the accessibility of OST STEM programs based on population served, geographical location, and instructional language. Assessing the literature in OST STEM will help us to understand if science education is equally accessible to girls as it is for boys. Because lack of a diversified workforce in STEM affects creativity, productivity, and the economy of the nation: inclusion of women will contribute to new ideas, perspectives, and more innovations (Koch, 2016).

7. METHODS

I chose scoping review as my methodology instead of systematic review because reporting out-of-school STEM programs for middle school female students is a broad research question with little literature available on this question. Therefore, this manuscript presents the first scoping review on out-of-school STEM programs for middle school female students by reporting, analyzing, and summarizing the characteristics of OST STEM programs as outlined by Arksey & O'Mailey (2005).

7.1 Methodology

The purpose of this project is to map the available OST STEM programs for middle school female students. Scoping review as a method provides an opportunity for comprehensively exploring a defined research question. Unlike other traditional reviews, scoping review is versatile and inclusive of studies with different methodological designs, "the intent is to synthesize the research in the topical area, by mapping or articulating what is known about key concepts, derived from an array of sources such as results from research studies, gray literature, and expert opinion" (Peterson et.al, 2017, pg.13). Similarly, the matrix method outlined by Garrard (2013) is used in this review to manage, synthesize and analyze the data provides a structure to assimilate the current knowledge in an appropriate context with the possibility of informing program and policy (Mulrow,1994).

7.2 Retrieval

Literature search measures outlined by Arksey & O'Mailey (2005) were applied to conduct a comprehensive, systematic, and unbiased search of the STEM programs for middle school girls. To secure a representative sample pool, relevant published reports, books, conference proceedings, and peer reviewed journal articles in English language were retrieved. The timeline for the search was restricted to January 2002- January 2018 because 2002 marks the implementation of "The Mathematics and Science Partnership Program", one of the leading NSF's STEM education program in K-12 for improving students' performance and teachers content knowledge on STEM (Kuenzi,2008). For a comprehensive literature pool four databases were searched; ERIC (EBSCO), Education Source, Academic Search Ultimate, and Compendex(Ei Village 2). These databases were used because; ERIC (EBSCO) and Education are the primary databases for K-12 education, Compendex (Ei Village 2) is a leading interdisciplinary database for Science & Engineering, and Academic Ultimate Search was employed to access a wide range of STEM related literature. Key terms used for the search are; *Female, Girls, Middle School, Junior High School, Grade 6, Grade 7, Grade 8, STEM(stem or science or technology or math or engineering), Science Camps, Afterschool programs, Summer Camps, Enrichment Programs, and Outreach program.*

7.3 Inclusion/exclusion criteria

For the purpose of inclusion, I used the following criteria:

- studies/ reports/ conference proceedings published between 2002-2018 in English language.
- Covers the population of United States middle school female students- grade 6-7-8

- Describes single gender STEM programs for middle school female students in out of school time.

I excluded studies which were:

1) Studies/reports/conference proceedings with a mixed gender (male-female) participant in OST

2) Studies reporting OST STEM programs for female students in elementary school, high school, and University

3) Studies published before January 2002

4) Studies or reports not in English

5) book reviews and commentaries on OST STEM programs which did not describe the program.

A total of 46 reports and articles met all these criteria and were included in the final sample pool. See ***Figure 1*** below which explains the rigorous literature search process used for this review.

7.4 Data synthesis and analysis

Each study was documented in a matrix using a coding design based on the following variables: 1) author/s, 2) journal/report/conference proceedings ,3) year of publication ,4) study type, 5) theoretical framework, 6) grade level, 7) sample size, 8) program content, 9) program duration, 10) program design, 11) instructional language, 12) funding, 13) program location, 14) program purpose, 15) program name. Each article was fully read and recorded in the matrix in order to maintain clarity and for thematic analysis.

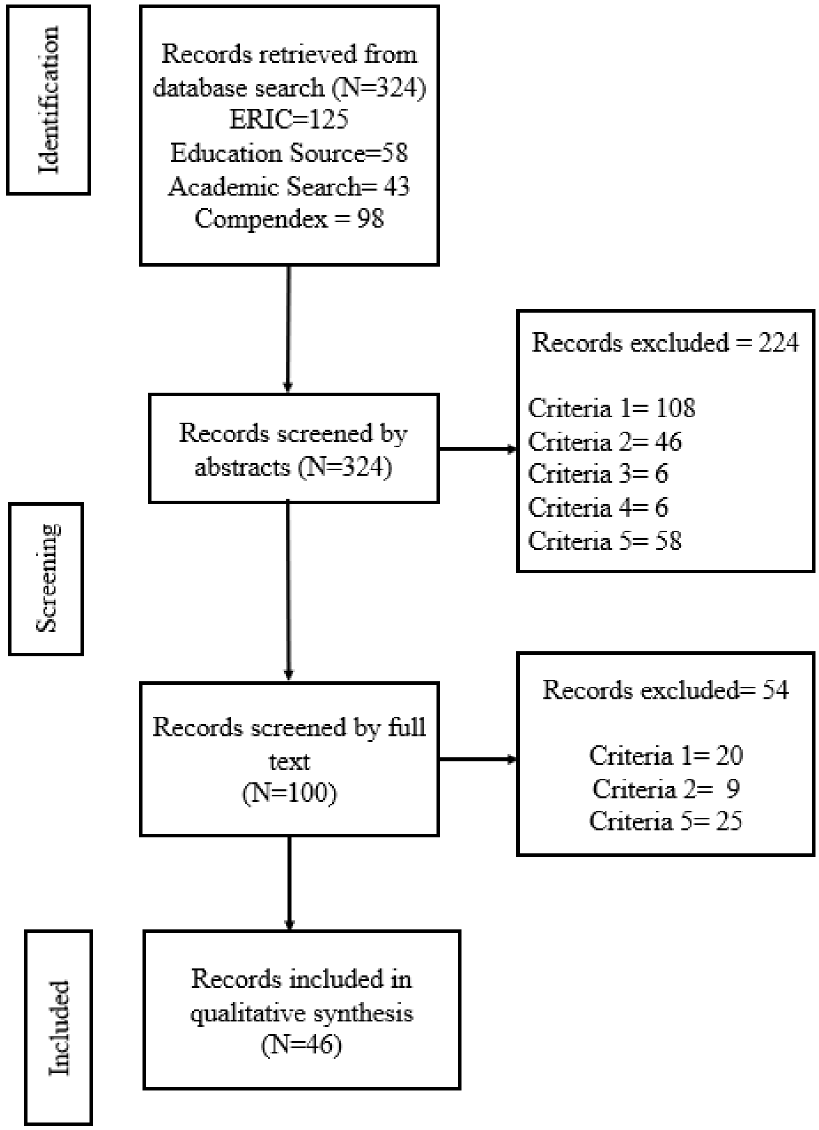

Figure 1. PRISMA flow diagram

The Criteria (Cr) describe the exclusion criteria applied in the literature search. Cr "1" indicates studies excluded because of male-female participants in STEM program. Cr "2" indicates studies excluded because STEM programs were for female participants from elementary school, high school, and university. Cr "3" indicates studies excluded because they were published before

January 2002. Cr “4” studies excluded because they were not in English. Cr “5” indicate excluded studies which did not describe the OST STEM programs.

8. RESULTS

8.1 Overview of the publication

Figure 1 represents the rigorous screening process of this review. The first stage of database search yielded 324 results which was followed by screening based on reviewing abstracts resulting in the exclusion of 224 articles, the full text of remaining 100 articles were reviewed. Only 46 articles met the inclusion criteria making the final sample. Among reviewed articles (N=46) the majority of articles (60.8%; N= 28) were published between the year 2011-2017 and the rest (39.2 %; N= 16) were published between the timeline 2002-2010. And these reviewed studies were published in 29 different platforms as conference proceedings (47.8 %; N= 22), peer reviewed journal articles (45.6%; N=21), and reports on OST STEM programs made up (6.5%; N=3). Of the 46 reviewed studies (63%; N=29) were published in the technical journals such as; American Society for Engineering Education (ASEE), Technical Symposium of Computer Science, Journal of Professional Issues in Engineering Education &Practice, ACM Tech, The Institute of Electrical and Electronics Engineers (IEEE), Career and Technical Education, and Journal of Women and Minorities in Science and Engineering. Reviewed studies with information on the authors indicate contribution of females as lead authors and contributors in 58.6% of studies (N=27).

8.2 Research question 1: What are the available OST STEM programs for middle school female students?

Between 2002-2018, 46 out-of-school STEM programs were conducted for middle school female students throughout United States.

Program Purpose	Program Name
Encourage women to take up STEM majors Motivate women to attend college and take up careers in STEM	Tech Trek STEM Camps for Girls
Exposing students to the world of engineering	Computer Science, Engineering, Math Middle School Girl Camp (CSEM)
Introduce girls to STEM related careers	STEPS: Science Technology Engineering Preview Summer Programs
To describe the MOTIVATE framework developed to introduce African American girls to Computer Science	MOTIVATE
To use and introduce innovative curricula in science and physical education	Not specified
Introduce sand analyzes assessment tools for two STEM outreach programs for middle school girls	Park and Ride Girls Technology Day
Outline the positive impact of STEM outreach program on young girls who later applied as undergraduates in STEM majors	Camp REACH
Introduce coding games strategy and discuss the result of the games coded by low income Latina girls	Not specified
To increase the number of girls producing technology	Girls Creating Games
To empower young girls and women to make informed choices in the field of engineering and technology	PIE- Partners in Engineering
Not mentioned	Not specified
To increase girls interest in STEM and to promote their participation in STEM related careers	GEMS- Girls in Engineering Mathematics and Sciences
Discuss the framework of Digital Youth Diva to spark interest in science among non-dominant girls	Digital Youth Divas
To study the personal science identities among middle school girls	Not specified
To discuss a program which promotes girls interest in Science and Technology	Not specified
To understand girl's perception of a STEM outreach program	Not specified
To introduce more females to the field of Engineering through robotics and computer programming	Mini GEMS- Girls in Engineering Mathematics and Science
To develop interest, excitement and self confidence among girls in STEM	Tech Trek
Discusses the learning experiences of girls in one day STEM program	Engineering the Body
Introducing computer science to girls	Cyber Girls Camp
Instilling skills, confidence, interest among n girls towards STEM	GEE- Girls Experiencing Engineering
Introducing a STEM outreach program	E-Weeks Girls
Describes the effectiveness of InSTEP	InSTEP- Inquiry Based Science Technology, and Engineering Program
To expose middle school girls to wide range of engineering activities	TEC- Technology Engineering, and Computing Camp

Table 1. List of OST STEM programs

8.3 Research question 2: What are the main characteristics of OST STEM programs for middle school female students?

1. Purpose

Table 1, represents a wide range of purposes of the out-of-school STEM programs for middle school female students. Based on these purposes three common themes surfaced in the OST STEM program which are: 1) *To motivate girls' participation in STEM* 2) *To introduce innovate curriculum in STEM programs 3) To understand and discuss STEM perception and experiences among middle school girls.*

1.1 To motivate girls' participation in STEM

Motivating girls' participation in STEM was an emerging theme among 80.4 % programs (N=37) with an emphasis on introducing engineering to young girls in order to pique their interest in STEM related careers. This purpose was also clubbed with in order to address the gender gap in STEM and motivate girls from historically underrepresented communities to pursue STEM in order to maintain self-esteem and confidence of middle school girls through STEM related interventions.

1.2 To introduce innovate curriculum in STEM programs

Present in only 10 % programs (N=5) this theme focused on introducing new assessment tools for STEM programs, integrating critical skills for scientific inquiry, accommodating scientific ideas of indigenous communities with modern science.

1.3 To understand and discuss STEM perception and experiences among middle school girls

Four programs (8.6%) aligned with this theme which explored the science ideas of girls from underrepresented communities, studied the personal science identities of middle school girls, and discussed about the perception on STEM held by middle school girls.

2.Sample characteristics

2.1 Participants composition

Among reviewed programs (N=46), 19.5% (N=9) studies did not report the sample size, of the remaining 80.5 % programs (N=37), sample size ranged from 6 to 143 participants in a program. Out of 46 programs, only 17 (36.9 %) reported the ethnic composition sample population in their Out-of-school STEM programs. The remaining programs 63 % (N=26) did not report the ethnic composition of the participants in the STEM program. Within these 36.9 % (N=17), 2 studies specifically focused on African American middle school girls, 1 program for only Native Hawaiin girls, and 1 program for Latinas, the remaining 13 programs reported diverse ethnic population such as; African Americans, Latinas, Native Americans, Native Hawaiians, Caucasians, Hispanics, and Asians.

2.2 Grade level

Majority of the reviewed programs (N=42, 91%) reported grade levels of participants in the OST STEM programs for middle school girls. Of these 91% programs, more than half (N=29) reported the participants in the OST STEM programs from the combined grade levels 6-7-8, while 8 programs reported participants only from 8th grade, 2 studies focused on 7th grade students as participants, followed by 3 programs with 6th graders as participants in the OST STEM program. The remaining studies (N=4, 9%) did not report the grade level of participants.

3. Program design

3.1 Theoretical lens

Among reviewed programs (N=46) only 8 programs (17%) reported the following theoretical framework; social cognitive theory, behavioral logic model, theory of constructionism, expectancy value model, interest development, situated learning theory, single gender learning, constructive perspectives, and identity theory. Remaining programs (N=38; 73 %) did not report any theoretical framework.

Theoretical Framework	Grade Level	Population	Program content focus	Program Duration	Program Design- Activities description
Behavioral logic model A social cognitive theory	Park and Ride Grade 6-8 Girls Technolog y Day Grade 6-7	N=41 N=48	Engineerin g concepts Physics, Robotics, Designing, programmi ng	Park and Ride= 2 days program Girls Technology Day =1-day program 2-3 times annually	Engineering hands on activities and lab experiments Park and Ride Physics, Robotics, Designing, programming Undergrad engineering students as mentors Parents information session and final display Role models meeting with women engineers
None	Grade 7	30	Engineerin g	2 weeks residential program Annual event	Experimental design Based on solving real life problems by engineering Mentoring by high schoolers, undergraduates and Female role models- scientist and engineers
Theory of constructionism	Computer game programm ing 6th grade	59 girls 72 % were Latina 22 % were White Majority language was mixture of English and Spanish. They are English Language	Computer game programmi ng	14 months after school program. Met twice a week during school year. Every day for three weeks during summer	Project based- supervised and guided by peers and teachers The introduction to programming was covered by tutorials Middle school teachers were also present

Table 2. Design of OST STEM programs

3.2 Program content

The 46 reviewed programs focused on a wide range of content in the OST STEM programs, however, the most dominant area of content was engineering which was significantly higher than other content areas; 67.3 % (N=31) programs designed the STEM program with special focus on various sub categories of engineering such as computer science, robotics, programming, and general engineering, as well as inputs from science and technology (**see table 2**). Programs with content focused on different categories of natural sciences such as; chemistry, marine biology, bio-medical, and space science represented 23.9% (N=11) programs. The mathematics content in STEM programs was reported in only 7 % (N=3) programs. Programs with content on history and nature of science constitute 2.17 % (N=1) of total sample.

3.3 Activities

Activities in out-of-school STEM contributed to a large portion of the program, therefore the reviewed programs (N=46) included different activities utilized to engage middle school female students in the STEM program. These activities are classified in the following themes; 1) hands-on-activities 2) mentorship and role models 3) field trips 4) parent involvement

- **Hands-on-activities**

Hands-on-activities engages students in experiential learning as well as translate ideas into actions. Almost all the programs (N=45, 97.8%) reported hands-on-activities such as project management, lab experiments, real life problem solving through engineering concepts, robotics, programming, web designing, app development, workshops, and do-it- yourself projects. These activities were combined with group work and team discussions.

- **Female role models and mentorship**

Female role models in STEM programs for girls is an emergent theme. Mentorship and interaction with female role models specifically from STEM related careers such as; scientists and engineers, is one of the major activities to address gender stereotypes STEM majors and related careers. Among the reviewed studies 37 % programs (N=17) reported activities such as; peer mentorship and female guest speakers from STEM related careers.

- **Field trips**

Many studies highlighted the field trip as an activity in the OST STEM programs. Field trips includes; lab visits, museum visits, aquarium visits, nature site visits, and educational exhibits. The sole purpose of these field visits was in order to learn about science, technology, engineering, and mathematics. Among the reviewed studies (N=10, 21.7%) reported field visits as part of the STEM programs.

- **Parent involvement**

Only (N=2) programs out of the total sample pool of (N=46) reported activities involving parents. These studies involved parents in activities such as, informational sessions on STEM program and final program presentation by middle school students on their learning in STEM programs.

3.4 Instructional language

A handful of programs (N=2, 4.4%) reported the instructional language used in the STEM programs. Both these studies used English and Spanish in delivering the program content to the participants. Majority of the reviewed programs (N=44, 95.6%) studies did not report any instructional language used in the STEM programs.

3.5 Program duration

Regarding the program duration of the OST STEM programs in the reviewed sample (N=46), 37 programs (80.4%) reported an annual OST STEM program ranging from 1 day to 3 weeks. Among these N=37 programs, STEM summer camps were most frequently reported (N=29). OST STEM programs throughout the academic year were reported in N=7 (15.2%) reviewed sample, these programs include weekly and biweekly STEM sessions.

3.6 Funding

Among the reviewed programs (N=46) funding sources for the OST STEM program was through various national and local sources with partial or full contribution (***see table 3 below***). National Science Foundation (NSF) was reported as a funding source among 34.7 % (N=16) of the reviewed programs. Female led organizations funded 17.3 % (N= 8) STEM programs in the reviewed sample. Only 3 programs (6.5%) reported any payments made by the participants. Funding source was not reported in (N=6, 13%) reviewed programs.

No	Year	Title	Instructional Language	Funding source	Program Location
1.	2013	Igniting the Spark: Tech Trek STEM Camps for Girls	Not mentioned	Funded by AAUW and their partners Parents pay just $50	California/ Florida/ Ohio/ Oklahoma- Since 2013
2.	2006	Show Them Nand Gates and They Will Come	Not mentioned	West grant initiative Funded by William and Flora Hewlitt Foundation All the cost related to the camp is paid by the fund	University of Wyoming
3.	2012	The STEPS Difference: 16 Years of Attracting Girls to Careers in Science, Technology, Engineering & Mathematics	Not mentioned	Program charge $ 450. 25 % participant receive scholarship	University of Wisconsin 2012
4.	2014	MOTIVATE: Bringing out the fun with 3D Printing and E- Textiles for Middle and High School Girls	Not mentioned	Partial support by NSF, US Defense Intelligence Agency Grant National Security Agency Grant	NA 2013
5.	2015	Empowering Girls with Chemistry, Exercise and Physical Activity.	Not mentioned	University of Rhode Island	Rhode Island
6.	2011	WE-IMPACT-Women in Engineering -Improving Program Assessment tools for Outreach and Retention Programs	Not mentioned	Rochester Institute of technology supported by female engineering faculty members	Michigan
7.	2017	A middle school engineering outreach program for girls yields STEM undergraduates	Not mentioned	NM	Massachusetts
8.	2011	Computer games created by middle school girls: Can they be	Not mentioned	Funded by NSF	California

Table 3. Characteristics of OST STEM programs

3.7 Program location

Majority of the programs N=15 (32.6 %) reported Southern region as a location for OST STEM programs including states (Texas, North Carolina, Virginia, Tennessee, Georgia, Oklahoma, Florida, Louisiana, and South Carolina). Midwest region constituted 26% (N=12) reviewed programs including states (Wisconsin, Ohio, Illinois, Michigan, South Dakota, and, Kansas). Among the reviewed programs (N=46), 17.3% studies (N= 8) reported the location of STEM programs in Northeast region (Rhode Island, Massachusetts, New Jersey, New York, Connecticut, Pennsylvania, and Vermont). Similarly, N=10 (21.7%) programs reported Western region as their program location including states (California, Montana, Nevada, Wyoming, Colorado, and Hawaii).

9. DISCUSSION

This study's purpose was to report, evaluate, and analyze a range of OST STEM programs available for middle school girls. While doing so, I am reporting and analyzing the characteristics of out-of-school STEM programs. The forty-six (N=46) reviewed programs included in this review provided a wide range of out-of-school STEM programs between 2002-2008 for middle school students, these OST STEM programs may provide guidance to teachers, researchers, and policy makers to understand different characteristics of STEM programs.

9.1 Engineering as the central focus

More than half of the programs included in this review emphasized on promoting STEM related majors and careers among middle school female students in order to minimize the existing gender gap in STEM. However, the content of the OST STEM programs is heavily focused on sub categories of engineering especially computer science, leaving out other critical areas of STEM such as; science (natural sciences), technology, and mathematics. Although there is no denying that engineering is traditionally a male dominated field where women have been associated with low efficiency and stereotypes affecting their work ability and self-efficacy (Schnittka & Schnittka, 2016), still the broader meaning of STEM is not mainly concerned with engineering.

This partial focus on engineering as the major content area in STEM programs can also be connected to a missing consensus on defining STEM among researchers, practitioners, and policy makers (Means et al., 2016). Additionally, it is possible that more funding is provided for STEM programs with a focus on engineering, also, the demand of engineers in economy leads to designing STEM programs promoting engineering. However, it is essential to present a diverse image of STEM because the central focus on engineering content in OST STEM programs is reinforcing the gender stereotype by making one aspect of STEM a comfortable place for young girls while making other STEM areas inaccessible (as shown in ***Figure 2***). This notion is justifiable because STEM fields like physics is largely associated with a masculine image, "girls and women have a skewed vision of physics, seeing it as a career that involves working alone" (Dare &Roehrig,2016, pg.2). According to O'Donnell & Cunnigham (2015) women bachelor's in physics make up to only 20%, while half of all the degrees in United States in awarded to women.

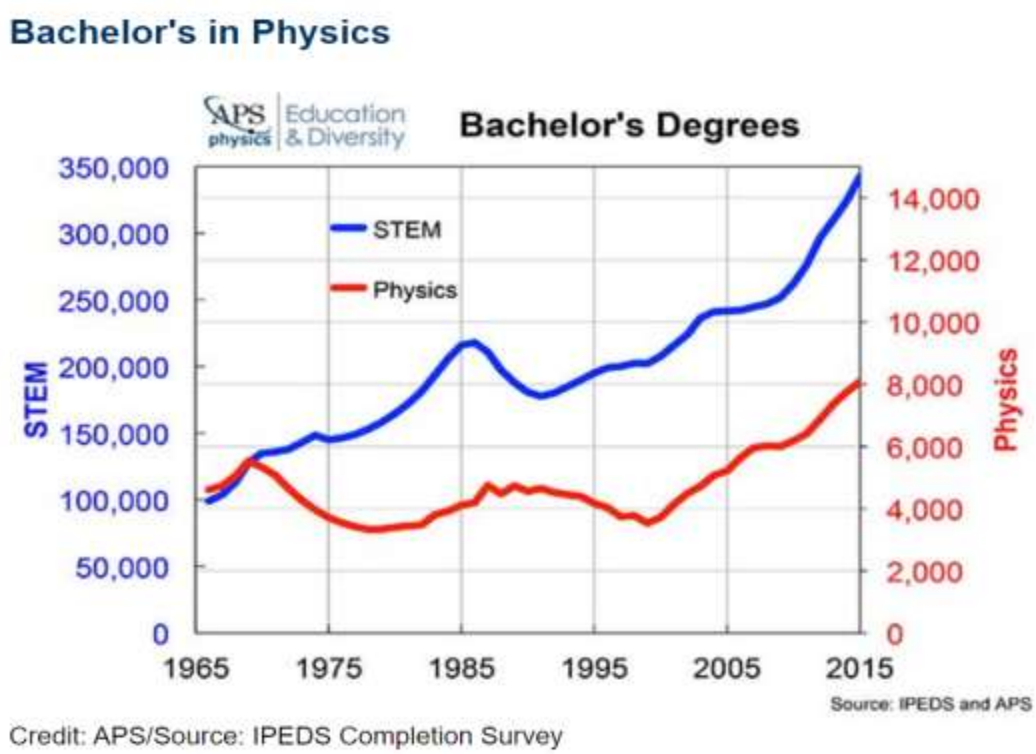

Figure 2. Difference in attainment of STEM degrees. Reprinted from *American Physics Society*

Equally important legislation from the 112th Congress regarding the emphasis on the engineering content in OST STEM programs is reported in the *Congressional Research Service* (Gonzalez, 2011) which states “award grants to states to plan and implement activities designed to integrate engineering education into K-12 instruction and curriculum” (pg.6). The legislation does not point towards any other specific aspect of STEM acronym as it does for engineering for K-12 education. This makes a clear contribution to the economic nexus between administration and neoliberal forces to utilize STEM education for the purpose of generating workforce rather than developing STEM literate citizens in United States (Hoeg & Bencze ,2017).

As per to Clough& Olson (2018), linking engineering and science practices under appropriate conditions can enhance learning and understanding of science and engineering concept leading to a “learning cycle” (Abraham, 1997), on the contrary, policy makers and practitioners have magnified engineering content while “marginalizing the science content.” Moreover, it is essential to understand that providing integrated STEM opportunities and “non-gendering” a particular aspect of STEM will expose young girls to new learning opportunities and engage them in scientific thinking influencing their perception towards STEM (Dare &Roehrig,2016).

9.2 Neglecting self-identity

Self-identity is how an individual construct one’s identity through the lens of gender, sex, race, ethnicity or a community, self-identity is major indicator of a student’s science identity in a classroom; science identity is an ability of an individual to perceive oneself as a person doing science, these two identities are entwined and affect the ways girls engage in science (Birckhouse et.al, 2000). According to Archer.et al, (2010), “the ability for girls to navigate a successful (achieving) science identity will be overlaid further by social class and ethnic identities" (pg.634), different shades of self- identities play a crucial role in shaping science identity among young girls. However, the process of acquiring science identity is rather more difficult for girls due to the social and cultural stereotypes attached with their gender.

It appears that the studies considered for this review do not place much value on the crucial role of self-identity in developing science identity among young girls because none of the studies have addressed this issue in OST STEM programs content for middle school girls. Even though studies (Wigfield et.al,1991; Eccles et.al, 1993; Dare & Roehrig,2016; Smith,2009) have overwhelmingly emphasized on the importance of adolescence and middle school as primary factors influencing cognitive development, academic achievements and young girl's attitudes towards STEM, OST STEM programs reviewed for this study have not explored the relationship between STEM education and adolescence, which contributes to developing self-identity while shaping young girl's attitudes towards STEM in middle school. According to Wigfield (1991)

"young adolescents 'mathematics, English, social, and sports self-concepts of ability and their liking of those activities became more negative immediately after the junior high school transition" (pg.560) …… "boys had significantly higher math- and sports- ability perceptions than did girls, and girls had significantly higher English-ability perceptions than did boys" (pg.558).

As young adolescent girls' self-concepts ability on math's declines during middle school, interestingly middle grade is classified as a critical phase in developing interest in STEM (Dare & Roehrig,2016). In order to determine adolescent girls' low self-concept, it is important to study the relationship between female students in middle school and STEM (see ***Figure 3***).

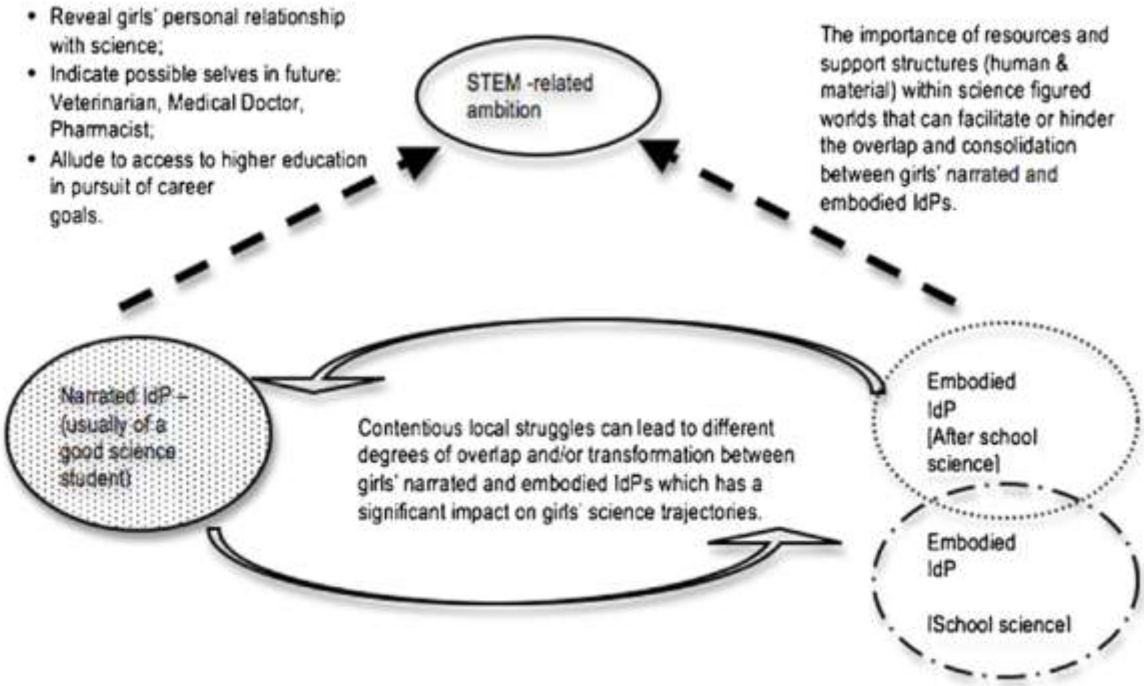

Figure 3. Relationship between self-identity and STEM. Reprinted with permission from the *Journal of Research in Science Teaching*. See (Tan et.al, 2013) for reference.

In the same fashion, majority of the out-of-school STEM programs included in this review were guided by the purpose of motivating young girls into STEM through introducing engineering or other STEM majors: according to Liben & Coyle (2014) this type of STEM intervention is called remediate, which “rest on the assumption that girls or women are missing some critical prerequisite for STEM engagement or success” pg.94 and providing training on spatial skills will remediate the lacunae therefore enhancing girls participation in STEM.

This lopsided approach is likely to provide a short-sighted STEM vision for girls but unlikely to address the deep-rooted gender gap in STEM while enhance meaningful participation of women. For this reason, it is essential to understand and take into consideration the social, cultural, racial, and historical prejudices and stereotypes these young girls have to encounter whilst paving the way in establishing their science identities, so that appropriate content and activities can be designed to provide an equitable, sustainable and conducive environment for girls to learn STEM (Tan.et al, 2013).

9.3 Supportive learning environment

Female role models- This study reviewed different characteristics of OST STEM programs, one of the most commonly adopted activity in the STEM program for middle school girls was interaction with female role models such as; scientist and engineers working in STEM related careers, this activity was included in 37 % studies.

Among many reasons for gender gap in STEM is the lack of female role models. Role models are instrumental and greatly contribute to middle school girls' perception and attitude towards STEM. Mentorship allows young girls to relate with their role models by sharing their backgrounds and career journey: according to Mosatche et.al (2013), "role models show that they have interesting lives outside their labs or other work environment, they begin to dispel girls' negative stereotype about scientists and engineers" (pg.24). A study focused on the after-school STEM program with female mentorship provides evidence of the significant contribution of role models in positively shaping young adolescent's self-efficacy and career choices towards STEM (Holmes et.al, 2012). Literature suggest that having a female role model in STEM reduces gender stereotypes helping girls to associate themselves with science enhancing their science identity and career ambition in STEM (Young et.al, 2013).

In contrast, findings by Cheryna et.al, (2013) indicate that female role models when compared with male role were no more efficient in shaping girls' interest towards computer science. Regardless of the effectiveness of female role models, it is essential to understand that female role models provide a platform for young girls to share their struggles and challenges allowing girls to make meaningful connections (Mosatche et.al, 2013). Although, it is critical to have a diverse and inclusive set of role models in respect to race, ethnicity, religion, and special need providing equal opportunity for all girls.

Informal learning activities such as field trips to labs, museums, aquariums, and natural site visit was included in 21.7% programs (N=10) reviewed for this study. Informal learning can be defined as "voluntary, self-directed, motivated by personal needs and interests, and often socially mediated; it engenders cognitive, affective, and other noncognitive outcomes" (Council,2007, pg. 20). Informal learning in OST programs provide a wide range of opportunities for students to comprehend science education and develop STEM related skills (Kong et.al, 2014).

Learning science outside of the formal school environment is getting acceptance among masses of the United States because of the flexibility in accommodating people of all ages and background as well as using easily available resources such as a community garden or park to learn science, and, most importantly, OST is not constrained by the rigidity of time which is essentially a trademark of formal settings (*National Research Council, 2009*).

Informal learning has been credited with improving female participation in non-traditional learning environment. Findings by Fadigan& Hammrich (2004) indicates that "informal science education programs can play an immense role in the lives of young women and low-income students" (pg. 857).

Collaborative learning in the form of group activities and team discussions were included in 97.8 % of the programs (N=45) reviewed for this study. Collaborative learning is broadly defined as a situation which actively engages two or more people from different backgrounds learn through teamwork such as; group discussions and group projects, providing diverse perspective and enhancing interpersonal communication skills (Barkley et.al, 2014).

Collaborative learning is key strategy in OST STEM programs because it allows members in a group to govern their learning minimizing the role of teacher in the process of knowledge generation and promotes equal participation of group members as they work to establish consensus in the group. Collaborative learning also dismisses the hierarchical social structure of a traditional classroom promoting relationship between students and teacher (Bruffee,1995).

9.4 Accessibility to out-of-school STEM programs

The reason for the growing number of OST STEM programs is to provide equal opportunity and accessibility to all historically underrepresented groups to STEM learning reducing the "math achievement gap between low and high-income students narrows when low-income students attend afterschool programs with greater frequency" (Krishnamurthi et.al, 2014, pg.7). However, findings from the participant composition of the programs point towards a critical issue that is lack of diversity. Of the included programs for this review, only (N=17; 36.9%) reported women of color as participants. With women, minorities of various racial, ethnic, socio-economic, and sexual orientations are underrepresented in STEM related majors and career, although support is provided to them through OST programs to increase their participation in STEM (Fadigan & Hammrich, 2004).

This underrepresentation of women of color in STEM is due to the historical dominance of white male in STEM, as well as the social and cultural pressure, isolation, and stress associated with academic achievement; therefore, it is essential to provide safe spaces for women of color to explore the intersectionality of race and STEM in order to help them persist through STEM (Ong et.al, 2018). And to design more OST STEM programs catering to the needs of women of color so that they have can participate and communicate their ideas in the field of STEM.

9.5 Insufficient out-of-school STEM programs

Out-of-school programs are gaining recognition nationwide for providing students with a supportive learning environment and positively influencing their participation towards STEM, although OST STEM programs are rapidly growing and assisting in STEM learning, *National Research Center (2015)* suggests that the existing OST STEM program caters only a fraction of the national need (Krishnamurthi et.al, 2014; National Research Center, 2015).

Findings from this review on the available OST STEM programs indicate that between 2002-20018 only 46 OST STEM programs were available for middle schools' girls in the timeframe of 16 years and the findings from the variable of program location of STEM programs indicate that OST STEM programs are not evenly distributed among all the 50 states of US, therefore aligning with the understanding that OST STEM programs are indeed not meeting the nationwide demands.

10. CONCLUSION

This review highlights the state of the current out-of-school STEM programs for middle school girls providing an opportunity for practitioners and policy makers to improve any specific characteristics of the OST STEM program. For example, data on program location and population composition can assist with designing accessible programs and interventions. Finally, this review will work as a guiding tool for future research on different ethnic and demographic avenues reported in the findings.

10.1 Limitations

Findings from this review provides a foundation to understand OST STEM programs for middle school girls. However, this study is not without its own limitations. First, is the search in article keywords, title, and abstract, many of the OST STEM programs are not covered as independent papers, they are generally combined with other research questions such as measuring the effectiveness of a certain OST STEM programs. Searching in key word, title, and abstract may have excluded potential studies with a focus on out-of-school STEM programs for middle school girls. Second, OST STEM programs are an interdisciplinary broad topic involving various local, national, and non-profit organizations, searching online academic databases could not have included all the reports, articles, books, book chapters, and peer reviewed studies. Despite its shortcomings, findings from this review, nonetheless provide a basic understanding on different characteristics of an OST STEM programs for middle school female students thus shedding light on the future research and practice to help design OST STEM programs accommodating the social, cultural, and cognitive needs of young girls.

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