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An Analysis of Young Children's Preferences on STEM Activities in terms of Gender

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Abstract

Presenting differences in the participation rates of genders in STEM activities may be a practical way to reveal that a solution to the gender gap should include addressing children at an early age, rather than at later periods in life. Thus, the purpose of the study was to investigate the STEM-related activity preferences of 3 to 8-year-old children. The sample of the study consisted of 193 children, between 3- and 8-years old attended STEM activities presented at the eight-hours-long science fair annually organized. Data was collected through a checklist. The results of the study revealed that the number of boys that attended the activities was greater than that of girls. More boys participated in the age group 5 than girls. On the other hand, girls' participation was higher than boys in age group 6. The results of the study also revealed that the activity preference of girls and boys did not differ for five out of six activities, i.e., Catapult Design, Jumping Wooden Sticks, Design Own Ship, Rescue the Horse, and Constructing with Mirror. However, it was found that among the six activities, boys participated in the magnetic wall activity significantly more than girls. This study may indicate the basis from which the gender gap emerged in STEM-related fields.

Keywords: STEM activities, gender-related preferences, gender gap, early childhood.

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Çocukların STEM Etkinlik Seçimlerinin Cinsiyet Açısından İncelenmesi

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Öz

STEM etkinliklerine katılım oranlarındaki farklılıkların cinsiyet açısından ortaya konması, cinsiyet eşitsizliğine yönelik önerilen bir çözümün, yalnızca yaşamın ilerleyen dönemlerinde değil, erken çocukluk döneminden başlayarak uygulanmasının gerekliliğini ortaya koymak için nesnel bir gerekçe sunabilir. Bu doğrultuda, bu çalışmanın amacı, 3-8 yaş arası çocukların STEM etkinlik tercihlerinin incelenmesidir. Çalışmanın örneklemi, her yıl düzenlenen sekiz saatlik bir bilim fuarında sunulan STEM etkinliklerine katılan 3-8 yaş arası 193 çocuktan oluşmaktadır. Araştırmanın verileri kontrol listesi aracılığıyla toplanmıştır. Araştırmanın sonuçları, etkinliklere katılan erkek sayısının kızlara göre daha yüksek olduğunu göstermiştir. Katılım oranları yaş gruplarına göre incelendiğinde, 5 yaş grubunda erkeklerin, 6 yaş grubunda ise kızların daha çok katılım gösterdiği belirlemiştir. Altı etkinlikte kız ve erkek çocukların katılımları anlamlı düzeyde farklılaşmamaktadır. Diğer yandan, altı etkinlik arasından, erkeklerin manyetik duvar etkinliğine kızlara oranla anlamlı düzeyde daha fazla katıldığı saptanmıştır. Bu bulgular doğrultusunda, bu araştırma, STEM ile ilgili alanlardaki cinsiyet eşitsizliğinin ortaya çıktığı temelleri işaret etme açısından önemlidir.

Anahtar Sözcükler: STEM etkinlikleri, cinsiyete dayalı tercih, cinsiyet eşitsizliği, erken çocukluk.

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Introduction

Girls and women are considered as lost in STEM-related fields during the period of education in their life (National Academies, 2007). According to Wertheim (2006), socially and culturally transmitted stereotypes have hindered women in their pursuit and maintenance of a STEM career. To explain, social and cultural stereotypes based on ideas that scientists are both male and masculine, have led to a lag of women pursing studies and carriers in STEM fields (Carlone, 2004). Moreover, research shows that a lack of women in STEM majors is caused by both formal and informal educational settings (Shapiro & Sax, 2011). Research conducted by Hill, Corbett, and Rose (2010) revealed that girls receive better test scores in math and display more of a tendency to continue their studies in mathematics, and to pursue a career in math-related fields when significant others, such as teachers and parents, stress that their intelligence can increase through experiencing and learning. This clearly reminds that, in terms of STEM education and gender preferences, the impact of adults and the learning environment is valuable and meaningful during the early childhood years.

Informal and unplanned scientific experiences of children (e.g. examining bugs in school garden) are supported by more scheduled learning experiences (e.g. school visit to museums or science centers), leading children to have a better understanding of scientific concepts (Gelman & Kalish, 2006) through developing their reasoning skills (Halford & Andrews, 2006). Bell and his colleagues (2009) emphasized that informal learning experiences across all cultures can contribute individuals to acquire new knowledge about the world in a systematic way in that informal but designed spaces such as science centers, aquariums, and museums encourage people to engage in science in a real-world context. Furthermore, school- and community-based as well as science-rich organizations give an important place for invaluable programs including scientific practices which are covered by maintained and self-organized experiences of science enthusiasts. Herein, there is an increasing number of proof that structured or structured but out-of-school science programs can arouse interest of children and adults toward science and promote their existing science interest which might be given rise to the selection of science career in future (Bell et al., 2009).

Definitely, in addition to formal educational settings (e.g., Bailey, 1993; Sadker, Sadker, & Klein, 1991), the messages related to gender stereotypes might be mostly conveyed by cultural factors, adults, peers and the mass media, as tools in the socialization environment of children (Hughes, 2003). All of these sources of gender stereotypes push children into believing and behave according to perceived notions of what is appropriate in regards to their gender that reach to a peak of rigidity in preschool years. These gender stereotypes affect children's behaviours, interests and expectations (del Rio & Strasser, 2013). Such as play activities (Caine-Bish & Scheule, 2009), toy preferences (Freeman, 2007; Ruble, Martin, & Berenbaum, 2006), interaction styles (Segal, Montie, & Iverson, 2000), choice of color (Weisgram, Fulcher, & Dinella, 2014), and even digital game preferences (Sullivan, 2016).

Resolving the gender-related STEM activity participation rates of children from the early childhood period, and how these are shaped by the cultural and social environment, may be important in order to understand the basis of the gender gap within the fields of STEM. Presenting differences in the participation rates of genders in STEM activity may be a practical way to reveal that a solution to the gender gap should include addressing children at an early age, rather than at later periods in life. In addition, the STEM education in Turkey, also in the world, is a new research field for early childhood education. Hence, to our knowledge there are limited research studies related to STEM education, specifically addressing gender differences in early years. The research studies which aimed to investigate gender differences between boys and girls in terms of their preferences for science, technology, engineering or mathematics by considering these fields individually or two of them have provided some findings related to gender related preferences of children (e.g. Christidou, 2006; Leibham, Alexander, & Johnson, 2013; Lynn & Mikk, 2008; Mantzicopoulous & Patrick, 2010). In pursuit of the abovementioned statements, the current study is intended to be an attempt at aiming to examine the STEM activity participation rates of the children who are at early childhood period.

Method

Participants

The data of the study was obtained within a science fair which is annually coordinated by one of the public universities in Turkey in 2016. In this fair, researchers of the study prepared a stand which included STEM activities addressing children. In this sense, participants of the study were children at the early childhood period, who voluntarily attended the fair and engaged in these STEM activities with their free choice. According to the National Association for the Education of Young Children (NAEYC) (2009), the period of early childhood includes children between 0 and 8 years of age. Therefore, 193 children, between 3- and 8-years old attended STEM activities presented at the eight-hours-long fair, are considered as the sample of this study. Participant children were not selected by researchers before the study, instead they were volunteers who visited the fair with their parents, peers or teachers during the day, and elected to take part in the prepared activities offered by the stand, of their free will. However, necessary permissions were received from the parents of children for the purpose of data collection. While each activity organized and offered at this stand was designed by the researchers as STEM activities to be conducted at the science fair, they were solely interactive activities for the participants.

STEM Activities

STEM activities were prepared based on "A Framework for K-12 Science Education: Practices, Crosscutting Concepts, and Core Ideas", which was prepared by the National Research Council (NRC) in 2012 for students attending 2nd, 5th, 8th and 12th grades. Just as the framework advocates that children should be engaged in scientific and engineering related processes, the dimensions of the framework have been a starting point for what would be included in the activities, and how they would be formulated. According to the NRC (2012), the framework includes three building-block principles, namely scientific and engineering practices which promote knowledge of how science and engineering succeed in boosting students' competence in the corresponding practices, crosscutting concepts which establish clear and scientific bonds across disciplinary boundaries, related mostly to science and engineering, and disciplinary core ideas.

The main idea behind the abovementioned framework is its specific focus on the integration of ideas and practices of science with the engagement of engineering ideas and practices, so as to have students become aware of science, and to help them become capable of carrying out science with a sense of deep wonder and appreciation by the end of the 12th grade. This aspect of the framework is very important in order to have the necessary knowledge of science and engineering, expressing personal ideas regarding related issues, utilizing scientific and technological information in daily life, being passionate about learning more about science, and preferring careers related to science, engineering and technology. In this regard, the framework which takes its roots in the previous studies, based on the learning and teaching of science, and integrating science and engineering knowledge on to a common ground for K-12 level, highlights important disciplinary core ideas and crosscutting concepts. On this model, K-12 science education should be built, in order to encourage students to engage in scientific inquiry and engineering design. For these reasons, the framework has been used as a guide while preparing STEM activities. The STEM activities and their detailed information, such as relevant problem situation, materials used, process followed, content involved and specific pictures are presented at the Table 1 at Appendix I.

Nature of the event

The science fair has been annually organized and hosted since 2006 by the same university which is one of the most prominent universities in Turkey. In 2016, this fair was coordinated with the name of ''Science is fun'' which was open to all visitors interested in watching, participating or engaging in science activities offered throughout the fair. In the fair, there were different stands arranged by researchers from different fields and prepared for visitors with a specific focus on their area of expertise. Each of the six activities was constantly followed by the four researchers and four teacher candidates with the necessary knowledge regarding STEM education, and who had participated in the brain storming and preparation of these activities. Before the event, research team of the current study which constitutes one male researcher and three female researchers working in the department of early childhood education in the same university as well as four female teacher candidates from the same department had participated in multiple brain storming in order to prepare the STEM activities and be charged with running the stand. Each member of the research team had knowledge of STEM education as well as each of the six activities. Although each member of the research team constantly followed a specific activity to which s/he was pre-assigned, with the support and guidance of two of the researchers, they rotated by turns during the event. Furthermore, before and during the fair, they abstained from using gender-stereotypic language in that none of the participant children was directed to a specific STEM activity conducted in the stand. Instead, children who visited the stand were asked with which activity they preferred to begin by respecting their free will.

The stand addressed children from three to eight years as a target group. They visited the stand with their significant others such as their parents and close relatives as well as their schools such as their teachers and peers within eight hours on weekend. The stand was set up over a 15 m² area on the second floor of the fair area in which relevant materials of six activities were located. Materials regarding ‘‘Constructing with Mirrors’’, ‘‘Design Your Ship’’ and ‘‘Rescue the Horse’’ activities were located at the front of the area in order for these activities to be easily seen by visitors. The materials used in the ‘‘Jumping Wooden Sticks’’ activity were located in the middle of the area, because it required a table to be used by the visitors who were interested in this activity, and it was placed in this region so as not to prevent visitors from passing towards the activities located at the back of the area. The back side of the stand area was designated for the ‘‘Catapult Design’’ and “Ways on Magnetic Wall’’ activities, due to the need for a greater number of materials. The area was open to all visitors, who were interested in watching, participating or engaging in activities offered throughout the fair. During the science fair, children who visited the stand were free to choose and attain whatever activity excited their attention. While children were engaging in any of the STEM activities, their significant others waited for children in front of the stand without participating or manipulating children physically or verbally.

Instrumentation

According to Gullo (2005), checklists are effective data collection tools in child studies, because its efficacy in assessing young children without intervening children, its simplicity to be used with them as well as its easiness to determine the existence of a certain behavior in them. Hence, in the current study, the data was collected with a checklist prepared by the researchers (see Appendix II). The checklist included three parts, which listed the activity chosen by the children, the gender of the child and the age of the child. The names of the activities were given in the first part of the list, which stated the ‘‘chosen activity’’. In the second part, the ‘‘gender of participant’’ was given, as there were two items to be marked, boy and girl. In the third and the last part of the checklist, the ‘‘age of the child’’ provided the items to be marked, the ages from three to eight. The instrument was easy to use so it did not require a special expertise. However, the researchers had discussed the issues that should be considered. That is, in the data collection process, it was important to make just observation regarding to activity preference of the child and not to intervene with the child at the selection process. The gender of the child and activity chosen by the child were determined through the observation of the researcher, whereas the age of the child was asked to the adult with the child to prevent the errors due to the prediction of the age of the child though observation of the researcher.

Data Analysis

Descriptive statistics and chi-square tests were conducted to determine the statistical difference between girls and boys, in terms of activity participation. Descriptive statistics and histograms were preferred to summarize categorical data; on the other hand, chi-square test was used to make comparisons based on categorical data between expected and acquired frequencies (Fraenkel, Wallen, & Hyun, 2012). In chi-square analysis for gender difference, the percentages of girl and boy participants in total number of participants as expected values were used to control unequal representation of different gender group, instead of 50% for each group (i.e., 41.50% for girls and 58.50% for boys).

Results

The current study aimed to determine the STEM related activity preferences of children at a science fair in terms of gender. Depending on the nature of this study descriptive statistics, like related frequencies and percentages are presented in the following charts. The results of descriptive statistics and the results of chi-square tests are also depicted in tables.

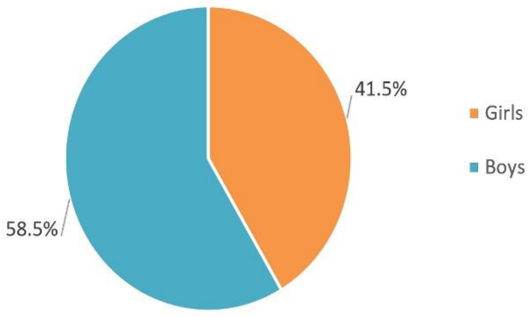

Figure 1. *Distribution of attendees by gender*

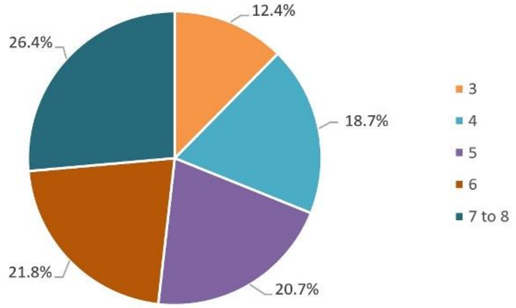

Figure 2. *Distribution of attendees by age*

A chi-square test was performed to examine the difference in gender-related preference of children for overall STEM activities (Table 2). The statistical results, χ^2 (1, n = 193) = 5.642, p = .018, indicate that the frequencies of children that attended the activities are not equally distributed by gender. Rather, the frequencies are statistically different from any figures that were expected to have naturally occurred. It appears that boys (n = 113) are disproportionately over-represented as participants of the activities and girls (n = 80) are under-represented (Figure 1). This result shows that boys participated in the provided activities more than girls.

Table 2

The result of chi-square of attendees' preference by gender

			Gender			
			Girls		Boys	
	X^2	p	f	%	f	%
Overall Participation	5.642	0.018	80	41.50	113	58.50

The results of descriptive statistics indicate that children aged 3 years old participated in STEM activities the least. On the other hand, the highest percentage of participant children were aged 7 and 8 years-old. Similarly, the percentages of children between 5 and 6 years-old, which, respectively, are 20.7% and 21.8%, were close in value. A chi-square test was performed to determine whether there is a significant difference between the preference of girls and boys for each age group (Table 3). The overall participation rates of girls and boys (41.50 for girls and 58.50 for boys) were used as propositions for expected values. The results of the tests revealed that the difference between boys and girls was significant in regards to their preference in age 5, χ^2 (1, n = 40) = 4.486, p = .034). More clearly, this result showed that significantly more boys participated in the age group 5 than girls. Moreover, there was a significant difference between boys and girls in the age group 6, χ^2 (1, n = 42) = 5.620, p = .018. This result showed that girls' participation was higher than boys in age group 6. On the other hand, result of the test revealed that there was no significant difference between the preference of girls and boys in age group 3, χ^2 (1, n = 26) = 0.186, p = .667), age group 4, χ^2 (1, n = 36) = 0.129, p = .720), and age group 7 to 8, χ^2 (1, n = 34) = 0.809, p = .368).

Table 3

The result of chi-square of attendees' preference for each age group

			Gender			
			Girls		Boys	
Activity	**X^2**	**p**	**f**	**%**	**f**	**%**
Age 3	0.186	0.667	11	45.8	13	54.2
Age 4	0.129	0.720	16	44.4	20	55.6
Age 5	4.486	0.034*	10	25.0	30	75.0
Age 6	5.620	0.018*	25	59.5	17	40.5
Age 7 to 8	0.809	0.368	18	35.3	33	67.7

* =p<.05

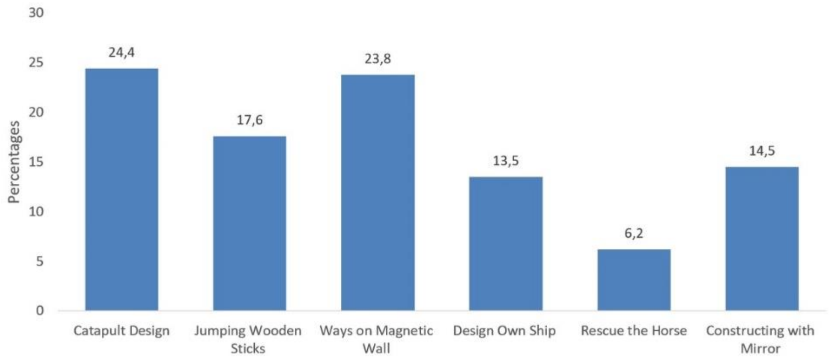

Figure 3. *Overall distribution of activity participations*

Figure 3 indicates the percentage of STEM activities preferred by children. According to this figure, the activities that are most preferred by children are, in order, the Catapult Design (n = 47) and the Ways on Magnetic Wall (n = 46). These activities are followed by Jumping Wooden Sticks (n = 34), Constructing with Mirror (n = 28), and Design Own Ship (n = 26), respectively. Moreover, Rescue the Horse was the activity least participated in (n = 12).

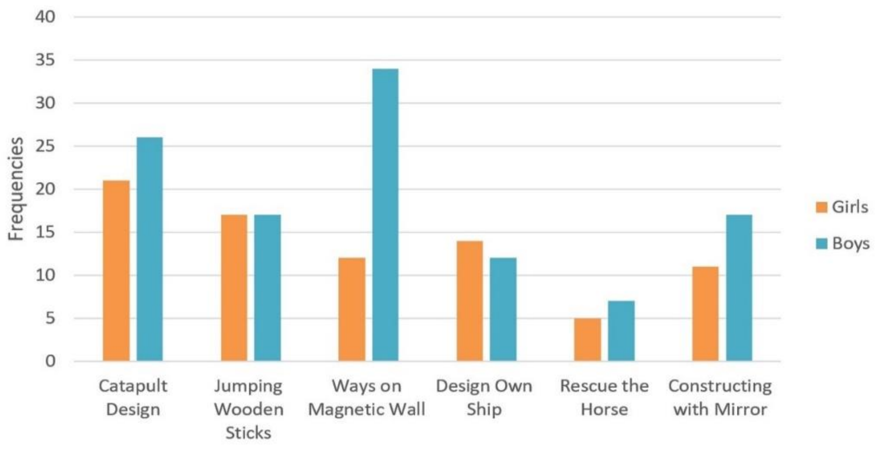

Figure 4. *Distribution of activity participants by gender*

Figure 4 indicates the distribution of activities by the participants' gender. According to the graph, the difference between the number of girls and boys in terms of their activity preferences is the highest in regards to the magnetic wall activity. The Ways on Magnetic Wall was preferred by 12 girls in comparison to 34 boys. The number of participants for the other activities were; 21 girls and 26 boys for the Catapult Design, 17 girls and 17 boys for the Jumping Wooden Sticks, 14 girls and 12 boys for Design Own Ship, 5 girls and 7 boys for Rescue the Horse, and 11 girls and 17 boys for Constructing with Mirror.

The chi-square test was performed to determine whether there is a significant difference between the preference of girls and boys for each activity (Table 4). In regards to the tests for activity participation, overall participation rates of girls and boys (41.80 for girls and 58.20 for boys) were used as propositions for expected values. The results are presented in Table 4.

Table 4

The result of chi-square of attendees' preference for each activity

			Gender			
			Girls		Boys	
Activity	**X^2**	**p**	**f**	**%**	**f**	**%**
Catapult Design	0.196	0.658	21	44.7%	26	55.3%
Jumping Wooden Sticks	1.012	0.314	17	50.0%	17	50.0%
Ways on Magnetic Wall	4.501	0.034*	12	26.1%	34	73.9%
Design Own Ship	1.632	0.201	14	53.8%	12	46.2%
Rescue the Horse	0.000	0.991	5	41.7%	7	58.3%
Constructing with Mirror	0.057	0.812	11	39.3%	17	60.7%

* =$p<.05$

According to the results of the test, the difference between boys and girls was significant in regards to their preference for the Ways on Magnetic Wall activity, χ^2 (1, n = 46) = 4.501, p = .034). This result showed that more boys participated in the Ways on Magnetic Wall activity than girls. On the other hand, result of the test revealed that there was no significant difference between the preference of girls and boys in terms of the Catapult Design, χ^2 (1, n = 47) = 0.196, p = .658), Jumping Wooden Sticks, χ^2 (1, n = 34) = 1.012, p = .314), Design Own Ship, χ^2 (1, n = 26) = 1.632, p = .201), Rescue the Horse, χ^2 (1, n = 12) = 0.000, p = .991) and Constructing with Mirror activities, χ^2 (1, n = 34) = 0.057, p = .812).

Discussion, Conclusion, and Recommendations

According to the findings of this study, a greater number of boys visited the stand and participated in activities, than the number of girls. Clearly, the number of boys choosing to participate in STEM activities was higher than the number of girls. This finding may be a clue in terms of understanding the difference regarding gender preference in STEM activities (Christidou, 2006; Leibham et al., 2013; Lynn & Mikk, 2008). The main reason why a great number of boys participated more frequently in STEM activities may be related to some gender-related characteristics attributed to some of the fields. That is, fields such as biology, language and art are seen as feminine fields, while mathematics, physics, chemistry and technology-related fields are regarded as masculine fields (Farenga & Joyce, 1999). Similarly, the fact that the fair where the study was carried out was a science fair, and that there were science and technology related products displayed at the remaining stands, may have led parents to make stereotypical preferences based on the gender of their children.

When the gender difference examined in terms of age groups, the results of the study revealed that there is a difference between girls and boys just in age group of 5 and 6. There might be several possible explanations on the difference between girls and boys in for those age groups, and not for others. First, in Turkey, the early childhood education includes children between 0 to 6 years old (Turkish Ministry of National Education, 2013). On the other, according to OECD (2018), in 2016 most of the children enrolled in early childhood education were at 5 and 6 years old. Children at these age who are enrolled early childhood education might have had chances to select which activity they get involved or which material they engage in because the nature of the early childhood education requires. In such educational environment, children might be more vulnerable to get and internalize the messages given by people (teachers, peers) around them, the messages might be about some activities' and materials being more appropriate for girls or boys. Second, for younger children in the study (at the age group of 3 and 4), most of whom are not in early childhood system, might be exposed less to the misdirection on their environment. There might be just the effect of their parents in the preference of activities. On the other hand, for children at the age group of 7-8 who are enrolled in primary education might not have a freedom of selection because in Turkish education context, there might be a more formal structure in primary education than early childhood education. Therefore, the arousal of different interest might be more difficult in more teacher directed as well as structured environments.

When the major characteristics of the activities are considered, it may be expected that some aspects of the activities might be interesting for children from different gender due to its characteristics considered appealing to girls or boys. On the other hand, the related literature has suggested contradictory findings for the effects of the content-related characteristics on children's preference. For example, some researchers found that boys are more interested in engineering-related activities such as playing with blocks (Desouza & Czerniak, 2002) and machinery (Murphy & Elwood, 1998). Considering the related literature, one could predict that some art-related materials, such as the paintbrush and paints required to be used in this activity, could have encouraged girls to engage in this activity, and may have appealed to them more than to boys (Early et al., 2010; Ruble, et al., 2006). In line with these research studies, for instance, the findings of the current study might be expected to indicate that more girls would participate in the Catapult activity, which was the only activity that included painting as a part of its required actions. On the other hand, the Design Your Ship activity did not include any painting, and might not be expected to be preferred by more girls than boys. Once again, it may be expected that the Design Your Ship activity would be preferred by boys more than girls, due to its engineering-related content. However, the results of the study revealed the opposite of this expectation. Rather, the findings of the current study, which did not provide significant difference for the preference of the activity preferences of boys and girls for most of the activities, revealed that the gender stereotypes that children are exposed to, can actually be less influential on children's preferences, when activities are appealing to interests of children in early childhood years.

However, significant difference between the activity choices of girls and boys was observed only at the Magnetic Wall Activity. Indeed, more than half of the children that selected the Magnetic Wall activity, were boys. The "Magnetic Wall" activity requires children to create some roads so that a ball can reach its target through the manipulation of some canals with the use of magnets. This process involves physical activities such as the lifting, manipulating and pulling of objects. These types of movements might have made this activity more attractive for boys, because these movements require children to be physically active and constructive. Clearly, the reason why boys chose the activity which requires more physical activity may be related to the differences between girls and boys in terms of their level of physical activity. Indeed, some studies state that boys are more physically active than girls, in activities conducted in preschool classrooms (Finn, Johansen, & Specker, 2002; Timmons, Naylor, & Pfeiffer, 2007). Moreover, boys are found to be more participant in activities related to machines and the manipulation of objects, than girls (Desouza & Czerniak, 2002; Murphy & Elwood, 1998).

Implications

The best way of creating equal opportunities for children in terms of participating in male-dominated fields, such as math and science, can be by valuing the understanding of math and science early in childhood (Bowman, Donovan, & Burns, 2001). Similarly, acts of teachers in the preparation of activities and setting selections are also crucial in having all children, regardless of their gender, involved in learning (Early et al., 2010). In this way, not only boys but also girls can have a chance to participate in different activities provided by teachers who consider all children as unique. At this point, it is also vital that teachers ought to provide activities for girls and boys in ways that involve creating challenges for the development of their current skills and for creating opportunities to practice different skills, which enhance their development and skills regarding STEM areas. That is, if children are challenged based on their skills, their development and the skills involved, may be enhanced. The key point here is again that teachers should give equal attention to both genders, instead of focusing on one particular gender, due to stereotypic thought where they show belief in ideas that STEM-related fields are more appropriate for boys, and that boys are more qualified to enter into these fields.

Another precaution which can be taken in both formal and informal educational settings to address gender bias in the classroom can be providing gender neutral materials and examples for children. Materials that include some gender stereotypic messages should be eliminated from learning environments, so as not to portray the wrong message, and instead gender-neutral materials should be welcomed by teachers (Aina & Cameron, 2011). In order to avoid conveying such a message, teachers can select gender-neutral materials which address all children (The Institution of Engineering and Technology [IET], 2016). Furthermore, if children are provided with materials that do include some gender attributes, teachers may eliminate the stereotypic preferences of children by encouraging them to play with their counterparts. According to the study conducted by Goble et al. (2012), children engaged more in playing with gender-neutral materials rather than gender-specific materials. This study also revealed that girls participated more in spending time with materials regarded as masculine while they were playing with boys in the classroom.

Limitations

Like any other study, the current study had several limitations in itself. Just as the study was built upon informal science learning experience which was open to the public, selection of the participant children was based on their interests and desires to choose a STEM activity to engage in. Herein, there was an obvious difference in the numbers of boys and girls participated in the study, resulting in a possible threat for the validity of the study. However, although it seems as a limitation, this unequal representation of different gender group was controlled by using percentages of girls and boys as expected values, instead of 50% for each group. Moreover, since this study investigated the participation rates of young children in STEM activities prepared for a science fair, examination of whether an interaction occurred between children and toys and materials which would have been interesting for children was beyond the primary aim of the study. For this reason, a possible interaction which might occur between children in early ages and toys and materials can be investigated by scholars in future research.

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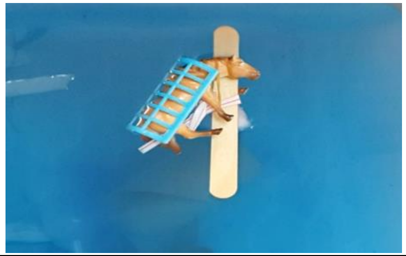
Appendices

Appendix I: STEM activities

Table 1 STEM Activities

Activity	Problem Situation	Materials	Process	Content	Picture
Catapult Design	Designing a catapult which enables children to throw sponges, dyed in primary colors, at the same target to obtain accent colors	Wooden sticks Sponges White board Finger paints Rubber band	Children are expected to design their own catapult mechanism by using spatulas and rubber bands in order to throw dyed sponges at a target.	Force Designing Measurement Angle Art	
Jumping Wooden Sticks	Making the first wooden stick in an line move the last one without direct contact	Wooden sticks	The activity was designed to ask children to prepare a pattern with wooden sticks and make further sticks move without touching them.	Potential energy to kinetic energy Pattern Designing	
Ways on Magnetic Wall	Designing a path to enable a ball thrown from a starting point at the top, to reach a pre-determined end point	Pipes with different shapes and sizes Ball Bucket White board	For the activity a variety of magnetic pipes, which provide a path for balls, were used. Participants came in front of a white board and designed their own path by using the magnetic pipes in order to drop the ball to a target on the ground. In this way, they had a chance to experience the impact of gravity, changes in potential and kinetic energies, and frictional force on objects.	Gravity Potential energy to kinetic energy Friction force Designing Measurement Counting	

Table 1 cont.

Activity	Problem Situation	Materials	Process	Content	Picture
Design Your Ship	Designing a ship which can float and move in accordance with air stream	Wooden sticks Balloons Waste materials	Children are asked to make their own ships with waste materials.	Buoyancy of water Designing model Problem solving Measurement Art	
Rescue the Horse	Finding a solution to make sinking toys float	Wooden sticks Miniature toys Easy-to-reach materials	Children are asked to design a construction in order to rescue a horse from drowning.	Problem solving Designing Buoyancy of water Balance Comparing	
Constructing with Mror	Creating unique buildings by using reflections on a mirror	Wooden blocks with different shapes and sizes Mirrors	During the activity two mirrors were located on the floor in a way that made a 90-degree angle. Children were expected to build constructions by using the reflections of the blocks on the mirror located below based on their existing mathematics knowledge.	Symmetry Shapes Quarter/half/whole	

Appendix II: Data collection instrument

Activity chosen by the child	☐ Catapult Design ☐ Jumping Wooden Sticks ☐ Ways on Magnetic Wall ☐ Design Own Ship ☐ Rescue the Horse ☐ Constructing with Mirror
Child gender	☐ Girl ☐ Boy
Age of the child	☐ Age 3 ☐ Age 4 ☐ Age 5 ☐ Age 6 ☐ Age 7 to 8