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Stem Education for Gifted and Talented Students in Turkey

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Abstract: In this article the historical and current process about STEM education for gifted and talented in Turkey will be described. Identification of giftedness will be presented at the beginning. The article will end up with detailed explanations of cultural practices regarding the STEM educations for gifted and talented in Turkey which are Beyazit Ford Otosan Primary School, Turkish Education Foundation Inanç Türkeş Special High School, Science High Schools and Anatolian High Schools entitled formal education practices; Science and Arts Centers, Educational Programs for Talented Students, Child University Research Centers entitled informal education practices; Ministry of National Education and The Scientific and Technological Research Council of Turkey entitled supporting agencies. Private schools, university based programs and after-school programs are basically supportive for gifted students at the elementary level. Those programs mostly focus on enrichment practices. There are some specific school programs for gifted students at secondary and high school levels. Enrichment and acceleration interventions constitute the underlying program differentiation philosophy at these schools. Besides, there are some supporting institutions for gifted people at all ages which basically organize Olympiads and summer schools. These institutions provide opportunities for gifted learners to study at higher levels and to interact with experts in STEM fields. Identification of gifted students relies basically on traditional IQ tests and academic success in most of these practices.

Key words: Gifted education, STEM education in Turkey, History of gifted education in Turkey.

INTRODUCTION

The education of gifted students in Turkey dates back to the 15th century (Sak, 2007). The Enderun School (Palace Schools) of the Ottoman Empire was one of the first governmental attempts to train gifted children. As a special school located in the Ottoman Palace, the Enderun's goal was to educate the most able children of the Empire to prepare them for the leadership in the Empire (Birgili & Calik, 2013). The Enderun system may also be considered as the first STEM (Science, Technology, Engineering, and Mathematics) education for the gifted and talented in Turkish history because its courses included astronomy, arithmetic and geometry along with other fields.

After the establishment of the Republic of Turkey in 1923, education evolved into a more Western-oriented style and was used as the major instrument to educate human resources to compete the world. Because of the world-wide competitions after the Second World War, Turkey started to invest more on the STEM education. This era opened up new pathways for the education of gifted students. It is no coincidence that this era was exactly the period when the first science high school was founded (Sak, 2007). For about twenty

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years, science high schools have increased in number and have remained the only school type for the gifted in the STEM areas. In 1990s, the Ministry of National Education (MNE) took a new step and started the first after-school program, "science and art center" at the elementary and middle school level.

Gifted education practices before the twenty first century can be considered as prototypes developed by the MNE. Program models for the gifted started to be more enriched and diversified with the new century because gifted education began to attract different agencies and institutions. In line with this trend, fortunately, universities and private education companies initiated more unique program models for the gifted and talented. Full-time special classrooms at public and private schools and after school programs at universities and private centers started to appear and spread out across the country with this trend.

Identification of Gifted Student

Speaking of identification of giftedness, the terms used for superior individuals in Turkey should be elucidated. The term "gifted" is generally not preferred by most of the experts and lay people (Shaughnessy, 2013). Indeed, many Turkish people have a negative perception of the word "gifted" because it is associated with elitism (Eris, Seyfi and Hanoz, 2008). "Highly talented" and "highly intellectual" are preferable in our culture. "Highly talented" refers to demonstrating special talents and "high intellectual" refers to high intellectual capacity. While most of the experts and lay people use both term, MNE prefers the term "highly talented" (Shaughnessy, 2013). The preference of MNE is quite paradoxical. MNE refuses to use ''highly intelligent'' term but prefers to apply traditional IQ tests to identify students (Shaughnessy, 2013).

Identifying gifted students relying completely or basically on traditional IQ tests is a common practice across Turkey, indeed. Besides MNE, private schools, after-school programs and gifted centers mostly use IQ tests and consider 130 IQ as the major criterion for identifying the gifted (Shaughnessy, 2013). However, it should be noted that some private schools use alternative assessment techniques (Eris, Seyfi & Hanoz, 2008).

Yıldız (2010) summarized the most used tools to identify gifted students. Some of those tools are Stanford Binet Intelligence Scale, Gessell Development Test, Wechsler Intelligence Scale for Children and Adults, Goodenough, Cattel Culture-Fair Intelligence Test. Gülgöz and Kağıtçıbaşı (2004) also mentioned Otis-Beta Quick Scoring Mental Ability Test, Torrance Tests of Creative Thinking and PeaBody Picture Vocabulary Test. Gülgöz and Kağıtçıbaşı (2004) posited a common characteristic of assessment tools used in Turkey: most of them are performance-type tests. They commented the ease of performance-type tests' adaptation as a justification for general preference.

Another reason of this high preference of performance-type tests may be explained with the limited resources of Turkey. The aim of identification of the gifted students in the formal education in Turkey is providing educational services to them. However, the Turkish government prefers to be very selective as accepting the top one percent of students because of the economic and quantitative limitations of those settings.

When we limit identification process in Turkey for STEM education, there is not a dramatic change, indeed. Gifted students are not provided with a qualified STEM education at elementary level except some private schools enriching mathematics and science curriculum. As Sak (2006) states, private schools offer a better education for gifted students in science and mathematics at primary level (K-4) currently, but income limits the accessibility of these schools. Furthermore, Science and Arts Centers started to accept students between grades 2-4 in the primary level which can be seen as a positive development for younger gifted children to reach support programs suit their intellectual development.

For secondary (5-8) and high school (9-12) levels, there are 4 foundations; Science and Art Centers (SAC), Science High Schools (SHS), Anatolian High Schools (AHS) and Turkish Education Foundation Inanç Türkes Special High School (TEFITSHS). SAC as out of school programs for gifted basically use IQ scores to identify and select gifted students. Science and Anatolian High Schools use the aptitude achievement test, but they can only accept the top one percent of the students who take the test. Also, the under-representation of the girls and students from the east, southeast and north parts of Turkey in Science and Anatolian High Schools is another major problem. The low schooling rate of girls and socio-economic disadvantage in those regions obstruct some students in terms of meeting the expected criteria and enrolling at those Science and Anatolian High Schools (Sak, 2006).

This summary of the situation brings about two basic identification problems in gifted education for STEM fields: under-representation and appropriate assessment tool/process. Leaving the under-representation out of this article as an economic and cultural issue of Turkey, we want to focus a little bit on the appropriate assessment tool/process for gifted education in STEM fields. As mentioned above, either elementary or secondary level, IQ or academic achievement tests are mostly preferred to identify and accept gifted students. That means domain specific identification of high talent/capacity in STEM fields is dismissed. This case is a major problem for gifted education in STEM fields which are based on high capacity on math, science and technology, since particular studies made by educators and psychologists (e.g. Krutetskii, Renzulli, Sheffield, Stanley) showed how important the domain-specific identification was for identifying students' mathematical and scientific abilities.

However, Turkey is not aligned with this current domain-specific identification. Fortunately, there is one promising study called Educational Programs for Talented Students (EPTY), which will be described at the "Educational Programs" part in depth. EPTY is the only current organization using domain-specific identification in gifted education for STEM fields in Turkey. These include Tests of Mathematical Talent, the Creative Scientific Ability Test, the Creative Mathematical Ability Test and the Scales of Early Academic Development. EPTY team believes that this identification process fulfills the requirements for a proper match of their program with the student profile (Shaughnessy, 2013).

Briefly, although there are not many research on identification of the high capacity on STEM fields in Turkey currently, university centered studies like EPTY or governmental organizations like Science and Art Centers give hope to keep up work.

Educational Programs for Gifted Learners in STEM Fields

In order to explain the situation about the education of the gifted in STEM fields more deeply, it would be helpful to take a closer look to the educational practices that are carried on different levels. First of all, the schools that have programs for talented learners in STEM areas will be explained. Then, we will take a closer look into the after school programs, and lastly, we will briefly discuss the supporting institutions.

Beyazıt Ford Otosan Primary School (BFOPS). The school offered special education for gifted based on the bilateral agreement between the Turkish Ministry of Education and University of Istanbul and the protocol aimed to develop a culture-specific differentiated program in order to meet the needs of gifted learners. The Istanbul University team applied and monitored the educational programs in this school via the «Gifted Education Project» they developed and proposed. This project has been carried on between the years 2002-2012. According to this Project, 24 gifted learners were selected for school every year (age 6-7) through a group and individual intelligence tests and they received education with their average learner peers.

However, in the core areas such as reading, mathematics, language and science in which the learning pace is important, students were divided into 3 flexible groups according to their progress and achievement level. As a framework, central curriculum is used with necessary grouping, enrichment and acceleration. Moreover, in order to meet the needs of gifted learners in different developmental levels; creativity, thinking and social-affective skills, courses were added to the program regarding those skills (Davaslıgil, 2009). By the presented differentiated curriculum, we can argue that, this school was providing an enriched curriculum for the gifted in science and mathematics in the early years of education.

Private Schools. As the awareness about the need of special education for the gifted and advantages of this differentiated education to the learning capital increase, private schools started to offer special classes or schools to the gifted learners. Those schools mainly follow the educational models proposed by the different universities' gifted education departments. Most of them identify the gifted learners via intelligence tests and aim to provide differentiated and enriched curricula for the gifted. With this differentiated curriculum, they serve for the mathematically and scientifically talented pupils, too.

Turkish Education Foundation Inanc Turkes Special High School (TEFITSHS). It is a unique high school founded in 1990 in order to provide special and differentiated education for gifted and talented high school students (Yıldız, 2010). It has a multistep identification process. They use a three-step selection process; "Exam (Knowledge and Apt)", "Individual Evaluation" and "Observation Camp". First, the applicants are given a knowledge-based exam, and the successful applicants are invited to take the second step, in which WISC-R is used. After that, the top 120 learners are invited to join the observation camp. It has another important regulation considering the under-representation of girls in gifted education, the school, enrolls 50% girls and 50% boys every year. Its curriculum is composed of exchange

program, international baccalaureate program and summer schools (Bilgili & Çalık, 2013). Students are offered a diverse learning environment both from social and STEM fields and enrichment and curriculum compacting strategies are widely used in the school.

Science High Schools. The first science high school was founded in 1964 in Ankara. Those schools' main aim is to provide appropriate education for the ones who are talented in science and mathematics. However, those schools' selection criteria is mostly based on academic giftedness, which means that students are selected via a country-wide exam, and no domain specific and talent based assessment tools are used. In their educational programs, mostly enrichment and course based acceleration interventions are used. Science high schools have a different curricula from those all other high schools. Their science and math curricula are deep, wide and accelerated. However, this is particularly true after 10th grade, and real differentiation experiences for gifted learners begin after that. Content differentiation is the most and widely used curriculum modification technique in Science High Schools. At the 9th grade the curriculum is similar to those in other high schools, but after 10th grade, weekly hours of science and math related courses' dramatically increase compared to the others and also knowledge base covered after this grade is also compacted and accelerated, too. Fast-paced instruction and acceleration compromise the process modification part of the curriculum at science high schools. For example, at the 12th grade, the covered content in science and math courses is similar to those offered in the first year in universities (Sak, 2010).

Besides these advantages, students do not earn extra credits for these courses, which can be considered as a huge drawback of the general education system. As the science high schools mostly focus on content, and the classrooms are teacher centered, no deliberate learning environment differentiation is applied. As mentioned in Selvi's (1996) research, most of the class time is spent for delivering content through lecturing and questioning. For the product differentiation dimension, we face again with some limitations. Although these schools highly emphasize science and mathematics; students' products seldom address real-life and scientific problems. At some high schools, homework dominates the educational practices instead of real-life scientific problems and projects.

By taking a closer look to the last decade, we can see that the number of science high schools all over the country were 61, enrolling 13188 students (8949 boys and 4239 girls) in 2003 and it increased to 144 in 2013 enrolling 38670 students (19316 boys and 19354 girls) (MNE, 2003; 2013b). It is important to get our scientifically and mathematically talented students to those schools more, because they not only specify in those areas, but also their academic success which is also high, will lead students to enter best university programs mostly specialized in STEM fields. According to the results of the university entrance exam held on 2012, 1.895.478 students took the exam, and the overall achievement percentage was 18.86 % whereas in the same year, 13391 science high school students took the exam, and overall achievement percentage was 62.19 %, which was high above the average (MNE, 2013b).

Anatolian High Schools. Anatolian High Schools were founded in 1970 and those schools are again selecting their students via a general exam mostly based on the academic achievement. In those schools, students attend a prep class at the beginning in which they learn a foreign language, and then, they continue their education. Although the general aim

of those schools is mainly based on the foreign languages, the quality of the mathematics and science courses are above the average, and the talented students' needs can be partially met by them, too, particularly for math and science. There were 432 Anatolian high schools in 2003 (number of overall students 205706, of which 111625 boys and 94081 girls) and in year 2013 the number of schools increased to 1627 (overall 895360, of which 420056 boys and 475304 girls). Those schools' achievement levels are considerably high in university entrance exams, too. In year 2012, the success rate was 53.94 %, which means 97513 learners of 180793 students were successful in the test (MNE, 2013b).

Science and Arts Centers (SAC). SAC are founded in 1993 by the General Directorate of Special Education Guidance and Counseling Services, and they constitute a special model designed for Turkey. SAC's aim is to enhance primary, middle and high school's gifted and talented learners' scientific thinking abilities, creativity, productivity, problem solving ability and social and aesthetic values (MNE, 2007).

Students are selected for these programs through a series of tests and evaluations. At the beginning, their teachers nominate the students; then, the list of the nominated children takes a group ability test in which screening is done. Only students who pass the cutoff on the group ability test are invited to individual IQ test. Although the group ability test's cutoff score can vary from center to center, the cutoff on the IQ test for placement is generally 130 (Sak, 2010).

SAC work like an out-of-school program and active in weekend or after school hours. The educational philosophy of SAC is mainly based on project and problem-based learning (MNE, 2007). As this is an enrichment program, the regular national curriculum is not followed; however, they do not have a written or established curriculum. Instead of this, students individually or with small groups work in projects in the areas they choose with their teachers and mentors. Yet, the initiative that has been taken by the General Directorate of Special Education Guidance and Counseling Services are promising for the future. Since 2014 they are working on the development of a curriculum framework for the gifted that are enrolled in SACs. SAC are composed of six departments, and the teachers are the head of those departments. Education process includes five different steps, namely orientation, support education (which includes social skills, problem solving techniques, group study techniques, scientific research techniques and social activities), discovery of personal skills, development of specific talents and projects (MNE, 2007; Seker-Sezginsoy, 2012). When the curriculum modification issue is taken into consideration, it can be argued that the education SAC's provide appears to be differentiated mostly in process and partly in content, learning environment and product dimensions. In SAC, process modifications dominate the differentiation interventions. Higher levels of thinking, open-endedness, discovery and invention, freedom of choice and cooperative learning seem to be the main elements of process modification (Sak, 2010). In content modification, not much predefined frameworks are used; instead, students are expected to learn what they need while they carry out research. As the teachers of the centers mostly guide students as tutors and mentors, the learning environment of the centers can be considered as student centered. Moreover, as the researches and projects carried out by the students require teamwork; students learn from each other and develop their social skills, too. Students' scientific studies mostly address real-life problems, and they are encouraged to collaborate with adults and experts in the areas they are working on. However, majority of the students' products are

not shared with the third parties, rather, they are usually presented only to the staff and the students in the centers (Sak, 2010; Shaughnessy, 2013).

SAC are very important programs for Turkey as they offer differentiated education in STEM fields, and also, as they have the most crowded student population in their organization. Currently, there are 70 SAC located in different cities of the country. Although statistically this number seems enough, it is far from being adequate, since SAC can only reach 4 % gifted population in Turkey.

Year by year, the number of the SAC are increasing, which means the chance of reaching more gifted learner is increasing, too. However, this is just one model, and as our youth population is high and keeps increasing, we need different models and educational programs. That is, the opportunities of gifted education in STEM fields in Turkey have to be multiplied both quantitatively and qualitatively.

Educational Programs for Talented Students (EPTS). EPTS is one of the most well-known research and theory-based STEM education programs for gifted students in Turkey and has become very influential in the field of gifted education. Furthermore, it has been accredited by European Council of High Ability (ECHA) as a European Talent Center in 2015. The EPTS was founded at Anadolu University in Eskisehir in 2007. It is a university based after-school program for students talented in mathematics and science. It's a comprehensive education program with well-articulated program components (Sak, 2011, 2012; Sak & Karabacak, 2010). Currently, it is offering programs for the 6-9th grades gifted students in science and math areas. It has six components. These components include identification, curriculum, instruction, assessment, program organization and teacher training models (Sak, 2011). All of the components were developed based on current research in gifted education. The identification and curriculum models of EPTS are based on the theory of successful intelligence (Sak, 2011). Being an after school program, the EPTS program model is one of the best match for Turkish educational system because Turkish educational system is not flexible enough for systematic and radical acceleration practices (Sak, 2006, 2007).

The EPTS identification is composed of four components. These are; domain specific identification, use of multiple criteria, sample based identification and natural selection – selective retention (Sak, 2011, 2012). The EPTS identification model uses both static and dynamic identification procedures through its natural selection -selective retention models. The static assessment includes performance on a mathematical ability test, a creative scientific ability test and school grades. The dynamic part of the assessment of the EPTS covers students' performance during the EPTS education.

The EPTS curriculum is composed of analytical, creative, practical and knowledge components and includes forty-four defined problem solving and thinking skills (Sak, 2013). Each component has a variety of problem solving and thinking skills, called EPTS skills. The analytical component includes ten skills, such as problem definition and forecasting. The creativity component has fifteen skills, such as fluent idea generation and creative imagination. The practical component consists of nineteen skills, such as initiating, setting priorities and completing tasks. Six of the analytical skills, thirteen of the creativity skills and eighteen of practical skills were adapted from the theory of successful intelligence. The rest of the skills of each component were identified from research on creativity and problem

solving. Finally, the knowledge component contains one year or more accelerated content standards of the general curriculum at each grade level. The EPTS model has been tested in several studies and found to be effective in developing gifted students' creativity in mathematics and science. Its social acceptance by gifted students was also found to be sufficiently high (Sak, 2011, 2013).

Child Universities (CU). Currently, many universities in Turkey are offering special after-school and summer programs for all students at their campuses. These programs have been called "child universities". One of these programs is located at University of Istanbul and was founded in 2011, offering education to gifted and talented learners aged between 10-17 years. The identification is done via WISC-R, and the selected students can take different courses from a pool accordingly with their interest. The courses are given by the university academicians (including professors), and range from archeology, genetics, physics, and math to linguistics. Most of the offered tracks are about science, mathematics and technology, which can provide enriched learning environment to those students who are talented on STEM fields. However students do not earn extra credits for these courses. Child Universities mostly run through winter and summer schools. As this programs has attracted attention across the country, different universities have launched similar programs in their campuses and managed to reach the gifted learners of their local regions. Currently there are 20 active child universities located in different regions of the country.

Funding and Supporting Institutions. The supporting institutions that have important roles in STEM education for the gifted learners in Turkey are; MNE and The Scientific and Technological Research Council of Turkey (TSTRCT). MNE is one of the most prominent institutions in education, as Turkey's educational system is hierarchically organized. MNE pointed out the importance of gifted education and published a new strategic plan about the education of the gifted for years 2013-2017. In this new strategic plan, apart the existing ones, new practices are proposed. Although there are important suggestions included in the new strategic plan that can excel the quality of gifted education in Turkey, it is hard to say that, adequate attention is paid to the STEM fields in the identification or in the educational level. However, some of the recently proposed practices such as the flexible acceleration opportunities (e.g. allowance to take college credits in high school and residential schools for gifted learners) can have positive effects on the education of able learners in STEM fields. TSTRCT is another crucial solution partner for the education of the gifted in STEM fields. That is, it provides a huge variety of support types for the students and researchers who are working on STEM areas. These support types include summer schools; Science Olympiads for the middle and high school students and a variety of scholarships are provided for the university students and researchers in the field. The Science Olympiads organized by TSTRCT is one of the best practices for the gifted in STEM fields. Olympiads give gifted learners a chance in order to be engaged in advanced research about science and mathematics and interact with experts in those domains. Moreover, the summer schools organized by TSTRCT in different educational levels are another important educational opportunity for gifted in which they can enhance their abilities in STEM fields.

CONCLUSION

In summary, above mentioned programs reflect the recent situation of STEM education. By taking into account those programs, we can claim that, although there were some practices about gifted education in Ottoman Empire, it was accepted as a research area since the early years of Turkish Republic. Those research constituted the basis for the recent educational policy of gifted education. However, we are in need of various models and a more structured and deliberate framework for progress, especially for specific interventions like STEM education for the gifted students. The prospective studies should be developed based on the local features and needs of different regions of Turkey, considering the sociological and geographical variety in our country. Moreover administrative regulations should be implemented to ensure a faster pace of learning and earning credits from higher-grade levels. These kinds of regulations will lead gifted and talented students to understand the nature of the STEM disciplines and to function as a scholar and to be productive as soon as possible. Besides the educational practices, the identification processes for talented students in STEM disciplines' regulations in Turkey, should be reconsidered. Identification of gifted students basically relies on the traditional IQ tests and/or academic achievement tests, across Turkey. This case is a major problem for gifted education in STEM fields, since particular studies made by educators and psychologists showed how crucial the domain-specific identification was important at identifying and nurturing students' mathematical and scientific abilities (Wertheimer, 1999). Fortunately there is one promising study namely EPTY, which is the only current program using domain-specific identification.

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