About Distance Mathematics Education of Gifted Students Studying at Secondary School

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Introduction

It is a known fact that more information was produced in the last four decades, also known as the Information Age, than in the past five millenniums. In information societies, greater use of low-budget internet tools (e-learning tools) that focus on students and that have no temporal or spatial limits dynamizes learning and helps knowledge to be carried to, shared with and spread in wide masses. And so, e-learning that complements and supports modern formal education gains more and more importance (Balaban, 2012).

COVID-19 infection caused by new coronavirus (SARS-CoV-2) was first observed in Wuhan, China, in late December 2019, which then spread to the whole world due to its high transmission rates (WHO, 2020). Based on United Nations Educational, Scientific and Cultural Organization's data (UNESCO, 2020), as of April 7, 2020, schools were closed in 188 countries due to COVID-19 pandemic, affected approximately 92 percent of the students all around the globe (1,576,021,818 students). In Turkey, on the other hand, the first COVID-19 case was reported by the Ministry of Health on March 11, 2020, and the Ministry of National Education suspended face-to-face education in all primary and secondary schools, as well as in all education institutions affiliated to the Ministry, and initiated a temporary distance education. Accordingly, the crisis was managed urgently, and the education system, which was structured in accordance with the formal education, had to be turned into a web-based distance education system. In the primary and secondary schools weekly lessons were rescheduled, while EBA and TRT offered much needed remedial education support, first one through the internet and the latter through television screen (MONE, 2020).

Distance education students have very different characteristics from those studying at formal education institutions. Their main characteristics that differ from the others include their age, educational background, objective, employment status, marital status and motivation (Özer, 1990).

In the Strategy and Practice Guideline for Education of Gifted Individuals (2013) prepared by the Ministry of National Education, General Directorate of Special Education and Guidance Services, individuals with higher abilities than their peers in such areas as intelligence, creativity, art, leadership capacity, motivation or special academic fields are defined as gifted individuals. Main principles and values to be taken into consideration

in education of gifted students with special talents include:

- innovation and creativity,
- originality, flexibility and dynamism,
- an education environment that appreciates and supports differences,
- cooperation and team work,
- miscellaneous education models and identification.

Educating gifted individuals, who constitute approximately 2 to 3 percent of the society, making them productive individuals, and using their potentials for social development, is important for social welfare, society's future, and for its place among other countries. Thanks to their leadership skills, motivations, decisiveness, fast-thinking and creative problem solving abilities, gifted individuals serve as the engines that direct societies and accelerate development and change. Education of those people begins on the day they are born, and continues as a life long learning process. In Turkish education system, gifted individuals are educated in Science and Art Centers that fall under the scope of public schools and that are available in every city. Curriculums are enriched by adding or deepening activities horizontally or vertically with the aim of supporting academic development and increasing performance of gifted students. While implementing these activities, such areas as leadership, productive thinking skills, innovation, entrepreneurship and values education are attached greater significance. In-service training and distance education programs are created for teachers and managers serving at miscellaneous levels of education of gifted students to increase and improve their knowledge and skills of educating those special individuals. Seminars, conferences, workshops, panels and congresses are organized as well. In terms of educating gifted people, each country strives to define national standards and develop miscellaneous education models and programs in line with the principle of equal opportunity. Enrichment practices in education of gifted individuals have seven common characteristics in general:

1. Enrichment covers activities that address students' fields of interest.
2. It integrates high-level contents, processes and products.
3. It has a comprehensive and interdisciplinary content.
4. It supports effective, independent and self-learning.
5. It requires curriculum and education to be individualized and differentiated.
6. It develops creative problem solving skills and creativity.

7. It requires professional tools to be used in product development.

All enrichment theoreticians (including Renzulli, Frank Williams, George Betts, John Feldhusen and Penny Britton Kolloff, and Carol Schlichter) mentioned some or all of these characteristics in their own theories (MONE, 2013).

In the simplest way, mathematics is defined as "*an abstract form of life*". The factors that make mathematics significant can be summarized as follows: First of all, it is relevant to humans' desire to live. Humans want to live, and when they guarantee it, they want to live a quality life (Skemp, 1986). Mathematics creates the mathematical model (theoretical basis) of the solutions developed by people, and leads to emergence of thoughts that can serve as a model in many new inventions. The second factor that makes mathematics significant is that the natural assets and events act decisively, which can only be explained through mathematics. Third, which is relevant to the two above-mentioned factors, and which might be the most important one, is that fact that mathematics, and problem solving in particular, develop such skills as thinking, discussion, and reasoning. Apart from those natural factors, such other factors as the nature of the mathematical knowledge, children's mental development and needs, as well as the theories about how learning emerges have led to a movement in mathematics teaching (Altun, 2006). Due to their physical development children love playing games and sports activities, and their mental development leads them to think about problems, events and issues. "*They engage because they are interested, and they develop because they engage*" (Skemp, 1986). That is why they enjoy mathematical knowledge much more if they are the ones creating it. They do not like formulas or knowledge that are directly told. According to Şimşek (2006), it needs to be taken into consideration that there are many students with different learning styles. He therefore suggests teaching methods to be diversified, miscellaneous education environments to be used to present knowledge, as well as conceptual and experiential knowledge to be balanced.

The present study first addresses distance education and its development, and then introduces some programs, applications and websites that can be used in distance mathematics education of gifted students.

Process

The research method of this study is traditional literature review. In traditional literature review studies, scattered information in the literature is addressed holistically, and a connection is made with the points to be discussed or a synthesis is created (Baumeister and Leary, 1997). In the present study, first, distance education-related definitions are given, and then the phases and periods of distance education in the world and in Turkey, and the factors that carried distance education from the past to today were addressed historically. And finally, some programs, applications and web sites that can be used in

distance mathematics education of gifted students were introduced.

According to "learning pyramid" developed based on the studies of NTL (National Training Laboratories), such passive techniques as lecturing, reading and audio-visual presentation contribute learning at a rate between 5 percent and 30 percent, while the contribution of such active techniques as discussion groups, do/apply, use and teach others reaches up to 50 percent, 75 percent and 90 percent, respectively (NTL Institute for Applied Behavioral Science). It is known that the use of animations, simulators, class videos and other similar free-of-charge resources in e-learning methodologies accelerates learning and makes it more effective. These resources do not only support the quality of formal education, but they also constitute the most significant source of information of the distance education system (Balaban, 2012).

Distance Education

Such terms as distance education, distance learning and distance teaching are often used interchangeably. And their explanations are usually similar. According to Kazmer and Caroline (2001) distance education provides people with rare opportunities to study, but it does not concern their conditions or occupational obligations. The term distance education was initially used as a synonym of "correspondence course", but then televisions were used for distance education. But it really nourished thanks to the communication technologies including videos, teleconference systems, e-mails and internet. Based on the definitions of researchers, distance education can be defined as an education system in which the teacher and the learner, who are physically at separate locations, can adjust the training according to their own paces and capacities, use education technologies and continue their high quality learning and teaching activities in a productive manner (Balaban, 2012).

There is a wide range of distance education technologies including correspondence courses, printed materials, radio, television, audio and video tapes, multimedia, computer assisted education, e-mail, internet, databases, satellite technologies, video conferences, virtual reality and augmented virtual reality etc. They can be grouped as interactive and non-interactive education methods. Developments in internet and communication technologies have reduced the cost of distance education, and provided such opportunities as interaction, use of rich visual materials, and simultaneous and non-simultaneous applications. Interaction and communication are of great significance in education. When they first began to be used, distance education technologies were mostly non-interactive, but thanks to the developing technology learner-teacher, learner-learner and learner-teacher-material interactions have increased. Interactive distance learning systems can be divided into two groups, considering if the interactivity is synchronous (simultaneous) or asynchronous (non-simultaneous). Considering live (multi-cast or uni-

cast) and on-demand broadcasting in distance education, interaction can be one-to-one bi-directional and one-to-many one-direction, and thanks to modern technology one-to-many bi-directional interaction and communication is also possible. Each new technology brought a new distance education model. The technologies to be used have the potential to be used for different distance education purposes in miscellaneous environments such as text, sound, image and electronic media (Valcke, Leeuw and Kamperman; 2001).

According to Balaban (2012) distance education's advantages include reduced time requirement, reduced cost, greater number of opportunities for education, opportunity to reach greater number of students, increased information production and dissemination, easier and faster communication and interaction. Thanks to distance education programs, students are able to complete the whole education program or a part of it in a geographical location away from the education institute. Since it is accepted as a solution for education-related problems that cannot be solved with traditional methods, and thanks to the opportunities and flexibility it offers, distance education is gaining popularity. The most significant goal of e-learning is to spread more information to greater number of people. E-learning models include television / satellite / open education, video conference, asynchronous education, web or CD-ROM, PC-based, internet, live virtual class, live sound, application sharing and video, mixed models, live virtual class + asynchronous + face-to-face education models.

Commonly Used Terms in Distance Education

Traditional Education (Formal Education): It is a face-to-face formal education that takes place in the same location at the same time.

Distance Learning: It covers learning activities during which the teacher and the learner are physically in different locations.

e-Learning: It covers learning activities during which internet, a network or a computer is used. It is the other definition of distance education or distance learning.

Blended Education: In this type of education all kinds of technologies can be used, and traditional education can be integrated with different distance education models.

m-Learning: It means learning activities in which mobile communication tools are used.

Virtual Class: A group that is created to learn a certain content through a network.

Web-based Distance Education: Distance education activities in which web technologies are used.

Simultaneous (Synchronous) Learning: A learning during which individuals in different

locations simultaneously come together in a virtual environment using bi-directional communication technologies.

Online Learning: It means learning a content that is presented over a network.

Non-simultaneous (Asynchronous) Distance Education: It means education offered to learners at different times and in different environments.

Lifelong Learning: It means continuously learning throughout life.

Phases and Periods of Distance Education From a Global Point of View, Chronology

One of the models that paves the way for global education is distance education. Dating back to 1728, distance education began by mail, and its popularity increased at a corporate level in 1960s - approximately the same time when British Open University project was carried into effect - in European countries, North America and Australia. And then Asian, African and South American countries joined this rush (Taylor and Vernon, 1985). Table 1 presents the phases and periods of distance education from a global point of view.

Table 1. Phases and periods of distance education from a global point of view (Bozkurt, 2016).

Period	1st Period		2nd Period		3rd Period
	Correspondence		Audio-Visual Tools		Information Technology Based
Phase	1728 Letters	1925 Radio and TV	1970 Open University	1980 Teleconference	1990 - ... Internet - Web
Change	Teaching Centered			Learning Centered	
	Distance Education			Open and Distance Learning	

And today, thanks to the developments in information technologies, higher quality teleconference and internet-based applications are available. Such distance education practices make it possible for teachers and students to enjoy audio-visual communication even when they are in different environments kilometers away from each other (İşman, 2011).

Phases and Periods of Distance Education From the Viewpoint of Turkey, Chronology

The concept of distance education was discussed in Turkey from 1923 to 1960s. After 1970s, secondary education level distance education studies were conducted, experience was gained, and limited progress was made. After 1980s, and with the establishment of

Anatolia University Open Education Faculty, distance education began to be given at higher education level. During 1980s and 1990s, distance education at primary, secondary and higher education level matured, and became a system that served large student groups. Distance education gained popularity and acceptance thanks to the achievements made in those years. As of the end of 1990s and beginning of 2000s, information and communication technologies witnessed many developments, which increased distance education opportunities and made distance education serving millions of students a part of the mainstream education system (Bozkurt, 2017). Table 2 presents the phases and periods of distance education from the viewpoint of Turkey.

Table 2. Phases and periods of distance education from the viewpoint of Turkey (Bozkurt, 2016).

Period	1st Period	2nd Period	3rd Period	4th Period
	Discussion and Recommendations	Correspondence	Audio-Visual Tools	Information Technology Based
Phase	1923-1955	1956-1975	1976-1995	1996-...
	Conceptual	Letters	Radio-TV	Internet - Web
Stage	Incubation	Maturation	Mainstream	
Change	Non-formal Education	Distance Education	Open and Distance Learning	
	Training	Education	Learning	
	Teaching Centered		Learning Centered	

Distance Mathematics Education of Gifted Students

Certain basic tools are needed for distance mathematics education of gifted students. These tools include learning management systems that help students access asynchronous studies (Moodle, Maplesoft, Google Clasroom etc.), a live lesson platform (Adobe Connect, Zoom, Google Meet, Microsoft Teams, Skype, TeamLink, Google Hangouts, WhatsApp etc.) and an e-mail or live texting system to ensure individual or group communication. Researches show how significant quality and simplicity are in distance education. Accordingly, the content to be shared should not be too complex in order not to suffocate the students and cause them to give in. Especially the instructions given for asynchronous studies should be very clear.

In asynchronous platforms, students may be asked to do a pre-learning study, watch a video that will link the subject to their daily lives, or complete an engaging research

task before the classes. Students are required to understand mathematics, and actively structure new information on previous knowledge and experience (NTCM, 2000). Video creation programs (Powtoon, Animato, Explee, iMovie, Camtasia (paid) etc.) are used for video classes. Furthermore, distance education videos can also be created using screencast programs (Loom, Screenpresso, Screencastify, and Quicktime for Mac etc.).

And for synchronous classes, efficient activities can be designed for students. Before initiating live classes, teachers may highlight students' asynchronous studies, followed by concept formation activities, if new concepts are to be used in the activities. Such word cloud applications as Wordcloudy and Wordart etc. can be used for this purpose. Making the classes interactive and enriching them with activities during which materials are used together by the students are other points that should be paid attention to while working with gifted students. Geometry-related tools such as Wolframalpha, Maplesoft, GeoGebra, Sketchpad, and Cabri serve well in geometry-related activities, as well as in demonstration or comprehension activities (if appropriate). Such interactive applications as Geogebra Graph and Desmos can be used to model daily life situations and to make inferences. It is highly significant to create Q&A and discussion settings while teaching mathematics to gifted students, and such applications as Quzizz, FlipQuiz, and Kahoot Classic Mode can be used for this purpose. "The basic thing that help children learn" is (in-class) discussions that are based on students' problem solving methods and their own ideas (Wood and Turner-Vorbeck, 2001). When teachers want to go beyond solving questions and create a class board to reflect the ideas of all students, they can share the link of a previously created board during the live class, which will help them create a classroom board within seconds. Similarly, an interactive concept map can be created together with the students using such tools as Popplet. These tools can be used in asynchronous exercises too, but they should be placed into the design flow properly.

After synchronous classes, asynchronous exercises may be required in order for the students to reinforce what they have learned. This may include an interactive exercise prepared using such programs as LearningApps, Quizizz, Socrative, and Kahoot Challenge Mode etc., or a standard exercise for which books or printed worksheets (e.g. pdf) are used. Solutions of the exercises taken from books and the worksheets should be available in the asynchronous system. Since many resources use a QR-code, students should have a QR-code scanning program (e.g. Qrafter) in their tablets or mobile phones. Today, video solutions are preferred to be shared for students to watch. Accordingly, a solution video is created, which is then embedded into a QR-code using such programs as Unitag, Générateur de QR Code, and GoQR.me. Such web based games as Edpuzzle, Minecraft, and Lego are frequently shared for the students to practice, which help them review and practice what they have learned, while also providing teachers with feedback. For example, while making a video, questions may be added when required. Then the

answers are reported to those who have made the video, which gives the teacher the opportunity to evaluate the answers. In the asynchronous exercises, Google Documents, Google Slayts, and Google Spreadsheet can be used for collective studies, which increase interaction and contribute students' social development.

In order to measur and evaluate those live activities, such digital tools as EdModo and Google Forms can be used for measurements and assessments to be made during and at the end of the classes and at the end of the week. Furthermore, such applications as Wizer.me can be used to give more detailed feedbacks to children. These applications give students the opportunity to respond in writing, by drawing or through voice record, and the same methods can be used by teachers to give feedback. Questions, as well as lecture videos and documents can be added to the system, which makes it suitable for class review and practice studies.

Conclusion

While teaching mathematics to gifted students, standard activities should be enriched and some changes should be made. Within this scope, what comes into prominence is differentiation in learning outcomes in terms of horizontal and vertical expansion. Asynchronous exercises should be uploaded to the system for students who have greater interest in mathematics and who differentiate in this area in a positive way. These should be voluntary practices. To direct those students to mathematics studies proper communication methods should be used and their inner motivation should be boosted through suggestion. After completing those studies, students should be given feedbacks. Encouraging them to participate in miscellaneous national or international live events and competitions support their development in the field of mathematics. A similar approach should be adopted for students who have difficulty in activities. For those students, in some rare cases, over demanding tasks that will distract them from the process should be avoided, and they should be directed to basic exercises to reinforce upper cognitive outcomes. Accordingly, students' individual and group dynamics should be observed closely, and teachers should take required measures and ensure flexibility in activities.

References

Altun, M. (2006). The Teacher Trainees' Skills and Opinions on Solving Non-Routine Mathematical Problems. Paper presented at the 3rd International Conference on the Teaching of Mathematics, İstanbul.

Balaban, E. (2012). *Dünyada ve Türkiye'de uzaktan eğitim ve bir proje* önerisi *[Distance education in the world and Turkey and a project proposal],* İstanbul: Işık Üniversitesi.

Baumeister, R. F., & Leary, M. R. (1997). Writing narrative literature reviews. *Review of General Psychology*, 1(3), 311-320.

Bozkurt, A. (2016). *Bağlantıcı kitlesel açık* çevrimiçi *derslerde etkileşim* örüntüleri *ve* öğreten-öğrenen *rollerinin belirlenmesi [Interaction patterns in connecting mass open online courses and determination of teacher-learner roles]*, (Doktora Tezi) [PhD Thesis]. Anadolu Üniversitesi, Sosyal Bilimler Enstitüsü, Uzaktan Eğitim Anabilim Dalı. Eskişehir.

Bozkurt, A. (2017). Türkiye'de uzaktan eğitimin dünü, bugünü ve yarını [The distance education in Turkey yesterday, today and tomorrow]. *AUAd*, 3(2), 85-124.

İşman, A. (2011). *Uzaktan eğitim [Distance education].* Ankara: Pegem A Yayıncılık.

Kazmer, M. M. & C. Haythornthwaite. (2001). Juggling multiple social worlds: Distance students on and offline. *American Behavioral Scientist*, 45(3), 510–529.

Millî Eğitim Bakanlığı (MEB) [MONE]. *Basın açıklamaları [Press releases]*, Retrieved 30 November, 2020, from http://www.meb.gov.tr/

Milli Eğitim Bakanlığı (MEB) [MONE]. Özel *yetenekli bireylerin eğitimi strateji ve uygulama kılavuzu [Training strategy and implementation guide for gifted individuals] (2013),* Retrieved 30 November, 2020, from

https://orgm.meb.gov.tr/meb_iys_dosyalar/2013_11/25034903_zelyeteneklibireylerineitimistratejiveuygulamaklavuzu.pdf

Moodle-Open Source Learning Platform, Retrieved 30 November, 2020, from www.moodle.org

NCTM (2000). *Principles and standards for school mathematics,* Virginia: Reston.

Özer, B. (1990). Uzaktan eğitim sisteminin evrensel yapısı [Universal structure of the distance education system]. *Kurgu Dergisi*, 8, 569-594.

Skemp, R. E. (1986). *The Psychology of learning mathematics.* UK: Penguin Books.

Şimşek, A. (2006). Ön *bilgi. Eğitimde bireysel farklılıklar [Preliminary information. Individual differences in education].* (Ed: Y. Kuzgun ve D. Deryakulu). Ankara: Nobel Yayıncılık.

Taylor, J. C. and Vernon J. W. (1985). Why distance education? Distance education in Asia and the Pacific, *Bulletin of the Unesco Regional Office for Education in Asia and the Pacific*, 26, 1-12.

UNESCO (2020). *COVID-19 educational disruption and response,* Retrieved April 5, 2020, from https://en.unesco.org/covid19/educationresponse

Valcke, M. M., Leeuw, F. L., & Kamperman, A. (2001). *Evaluating digital distance learning programs and activities: studies, practices, and recommendations, World Bank Institute of the World Bank,* Retrieved 30 November, 2020, from

http://documents1.worldbank.org/curated/en/790431468161655983/pdf/489360NWP0Box31C10ES991211complete1.pdf

World Health Organization (WHO). *Q&As on COVID-19 and related health topics,* Retrieved May 10, 2020, from https://www.who.int/emergencies/diseases/novel-coronavirus-2019/question-andanswers-hub

Wood, T., & Turner-Vorbeck, T. (2001). Extending the conception of mathematics teaching. In T. Wood, B. S. Nelson, & J. Warfield (Eds.), Beyond classical pedagogy: Teaching elementary school mathematics (pp. 185–208). Mahwah, NJ: Erlbaum.