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STEM Skills for Students Who Are Blind or Low Vision

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ABSTRACT

In this study, a model study was conducted to match the skills needed in STEM education with the needs of visually impaired and low-vision students. The skills that emerged in the content of the study were presented with a framework and 27 objectives in accordance with this framework were shared as a table. With this model, it is possible to develop a curriculum to improve the STEM skills of visually impaired students.

Key Words: STEM Sklills, Low vision, Blind students

Görme Engelli ve Az Gören Öğrenciler için STEM Becerileri

ÖZ

Bu çalışmada, STEM eğitiminde gereken beceriler ile görme engelli ve düşük görme yeteneğine sahip öğrencilerin ihtiyaçları uyumlu bir model çalışması gerçekleştirilmiştir. Çalışmanın içeriğinde ortaya çıkan beceriler, bir çerçeve ile sunulmuş ve bu çerçeve doğrultusunda 27 kazanım tablo olarak paylaşılmıştır. Bu modelle, görme engelli öğrencilerin STEM becerilerini geliştirmek için bir müfredat geliştirme olanağı bulunmaktadır.

Anahtar Kelimeler: STEM Becerileri, Az gören ve Kör öğrenciler

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Introduction

Today, it is thought that it is a more meaningful approach for students to learn their science education together with other related fields, and an approach that includes science, engineering, technology and mathematics, called STEM education, is recommended (Siekmann & Korbel, 2016). Science teachers aim to train students to benefit from the disciplines mentioned while solving problems in accordance with the STEM approach. In this sense, it is important to define STEM skills to clarify learning outcomes. This article examines STEM skills in the context of students with visual impairment and low vision.

The main reason why STEM skills are difficult to define is that it is difficult to define the skills needed in regions where the four areas mentioned intersect and differ. For example; Knowing the basic concepts in science is important for understanding the problem and researching the solution, and the ability to follow technological innovations will make the solution easier and more economical. As can be seen from the example, the skills needed may differ depending on the situation of the problem. For this reason, it is necessary to define STEM literacy as a skill, which includes the literacy of all mentioned areas (Bülbül, & Sözbilir, 2017).

STEM Literacy

Students who can decide what kind of research and interpretation they should carry out with the least amount of information they need to know when they encounter information related to science, technology, engineering and mathematics have STEM literacy. STEM literacy encompasses literacy in all mentioned fields. Therefore, in order to be able to read and write in the STEM field, it is necessary to have the literacy requirements and the necessary skills in other fields. These skills are summarized in Table.1 according to the fields.

Table.1 Components of STEM Literacy

The name of field	*Science*	*Technology*	*Engineering*	*Mathematics*
The name of skills	Science process skills (Bülbül, 2013)	Technological Pedagogical Content Knowledge (TPACK) and Technological Skills (De Broucker, Bordt, Read, Harris & Zhang, 2001; Watulak & Kinzer, 2013).	Engineering/Designing skills and Universal Design (Mohan, Merle, Jackson, Lannin & Nair, 2009; Nair, Patil & Mertova, 2009; Rose, 2000)	Problem solving skills (Norman, 1988; Schoenfeld, 1980).
Content of the skills	Observation, Comparision and classification, Cominication, Measurement, Prediction, Inference, Forecasting, etc.	To be able to choose the technologies suitable for the needs and to use the technological device in accordance with its purpose	Empathizing with the user, defining the need, generating ideas, prototyping, testing, redesigning, giving importance to flexible use and accessibility so that it can be used by everyone	Be able to calculate correctly, use symbols correctly, perform operations in the correct order, etc.

All STEM literacy skills are cognitive/mental skills and if the student does not have mental problems, they can easily have these skills. There are also many visually impaired people working in STEM career fields. For example; It is known that there are academicians who are visually impaired and work in the field of physics. The elements that make a visually impaired student a physicist are the student's self-awareness, self-orientation, flexibility and accessibility of the learning environment (Bülbül, 2016).

a. Science Process Skills

Scientific process skills; These are the skills that scientists need to have while doing science, and they are all skills that the visually impaired can do when appropriate technologies are used (Bülbül, 2013). Science process skills such as observation, comparision and classification, cominication, measurement and prediction are similar to problem solving skills, as science is made to investigate subjects that people are curious about and to produce solutions to common problems.

b. TPACK and Technological Skills

For teachers, knowing the content is not enough. It is also necessary to know what kind of pedagogy the content will be given. Today, it is widely believed that using which technology to provide the educational approach appropriate to the content is a separate type of knowledge (TPACK). In order to decide which technologies can be used in STEM education, it is necessary to follow current technologies and to realize the advantageous and disadvantageous aspects of existing technologies. Considering that the visually impaired can use smart phones (Bülbül, Yiğit & Garip, 2016) and do robotic coding (Bülbül, 2017), it will not be a problem for the visually impaired to use accessible support technologies.

c. Engineering Skills and Universal Design

When the communication, critical thinking, innovation, leadership, creativity, etc. skills that engineers are expected to have are examined, it is seen that they are largely similar to the skills that are known as 21st century skills and that a person/student should have in business life/school. Considering the design-oriented thinking requirements of engineers and people with different needs such as the visually impaired, the ability to make universal design comes to the fore among engineering skills. Universal design means design that can be used by everyone, and engineers should always consider the user in the machines, devices and vehicles they produce (Rose, 2000). Therefore, skills such as empathy and communicating with different users are also very important.

d. Problem Solving Skills

With a critical and inclusive view, STEM education research appears to be based on problem solving literature. For this reason, it can be summarized as being aware of the steps that are known as problem solving skills and generally followed while solving the problem. In order to solve a problem, it is very important to be able to take steps such as feeling the need to solve the problem, defining the problem, looking for options for the solution, determining the action, implementing the chosen action and evaluating the result (Norman, 1988; Schoenfeld, 1980). As a result of these steps, it is thought that the problem can be solved. If examined carefully, these steps are based on two basic thinking skills, creative and critical thinking. While criticizing existing solutions, new solutions are created in the mind and these new ideas are put into a critical process again. As a result of this thinking cycle, the problem is expected to be solved.

All students with BLV who do not have mental differences because their problem solving skills are related to mental processes; they will be successful if they are given enough time, technological support to work independently, and a collaborative and flexible working environment. Assistive technologies and working environments with a culture of collaboration will enable students to better understand the problem and find the solution not only by instinct but also by experimenting with the additional time and flexible working environment provided (Garip & Bülbül, 2014).

Skills from Cognitive, Affective and Psychomotor Domains

STEM skills are the skills needed to solve problems, produce projects and design in the field of Science using technology and mathematics. While most of these skills are cognitive, there are also affective and psychomotor skills such as developing and maintaining a positive attitude towards STEM education and using materials and devices correctly. There are different levels to develop positive attitudes towards STEM education. For example; If you are new to a field, fun activities, interesting topics if you have been working in that field for a while, and your efforts to specialize if you have been in the same field for a long time can cause you to develop a positive attitude towards STEM education. Therefore, having fun, being curious and specializing in affective areas reveal three different skill levels.

If we reflect STEM skills in three different dimensions, we can reach a model (Figure 1). According to this model, visually impaired people either do their jobs without using technology and support from others, or they do their jobs with the support of technology and/or other people. Apart from physical activities, when mental activities are examined, there are cognitive activities such as deciding the problem and solution, creating and thinking critically. Levels in the affective dimension indicate the purpose of the skills.

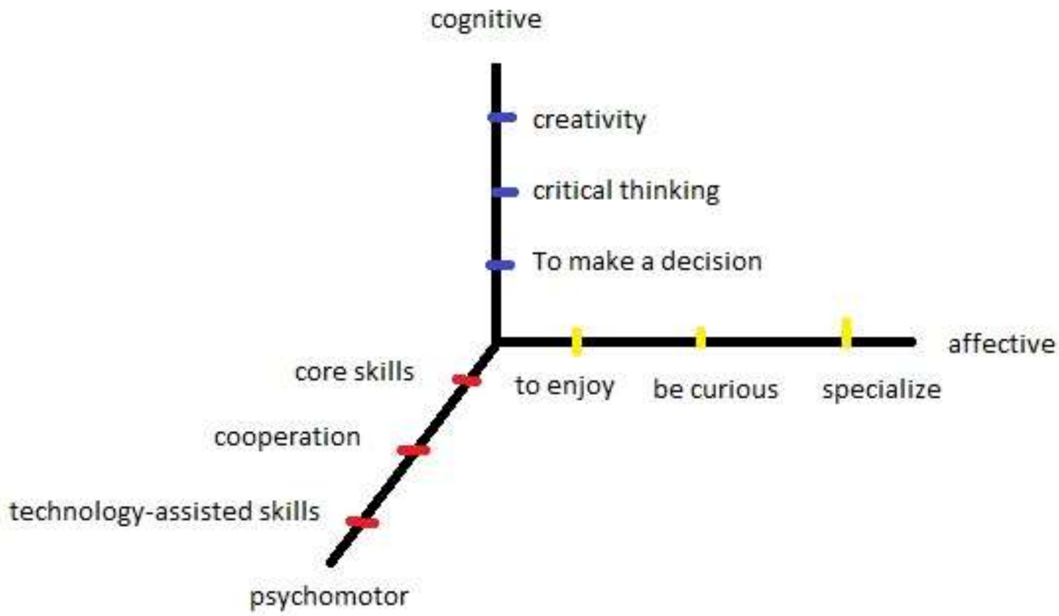

Figure.1 Cognitive and physical (Psychomotor) activities for different purposes (Affective domain)

Conclusion

In this article, in which the skills needed in STEM education are reviewed, skills in different fields are handled in line with current needs and brought to a framework that the visually impaired can also do. It is possible for the visually impaired to become literate in STEM subjects, either individually or as a team, and by using accessible technologies. Different mental skills are required during the work that can be done individually or as a team for different levels. For this reason, it can be helpful to introduce current technologies to the visually impaired, to enable them to communicate effectively within the group, and to help them design different activities by enabling them to see different learning environments. At the end of this research, the following (Table.2) STEM skills list is recommended for BLV students. The skills on this list also apply to students who see.

Table.2 List of STEM Education Skills for BLV

Skill Number	*Explanation of STEM Education Skills for BLV*
1	He/She can produce fun activities/projects/ideas on science subjects alone.
2	He/she can produce activities/projects/ideas related to science subjects that he/she can specialize on his/her own.
3	He/she can produce activities/projects/ideas that arouse curiosity about science subjects alone.
4	He/She can produce fun activities/projects/ideas on science subjects with his/her friends.
5	He/she can produce activities/projects/ideas related to science subjects that he/she can specialize with his/her friends.
6	He/she can produce activities/projects/ideas that arouse curiosity about science subjects with his/her friends.
7	He/She can produce fun activities/projects/ideas on science subjects by using technology.
8	He/she can produce activities/projects/ideas related to science subjects that he/she can specialize by using technology
9	He/she can produce activities/projects/ideas that arouse curiosity about science subjects by using technology.
10	He/She can criticize fun activities/projects/ideas on science subjects alone.
11	He/she can criticize activities/projects/ideas related to science subjects that he/she can specialize on his/her own.
12	He/she can criticize activities/projects/ideas that arouse curiosity about science subjects alone.
13	He/She can criticize fun activities/projects/ideas on science subjects with his/her friends.
14	He/she can criticize activities/projects/ideas related to science subjects that he/she can specialize with his/her friends.
15	He/she can criticize activities/projects/ideas that arouse curiosity about science subjects with his/her friends.
16	He/She can criticize fun activities/projects/ideas on science subjects by using technology.
17	He/she can criticize activities/projects/ideas related to science subjects that he/she can specialize by using technology
18	He/she can criticize activities/projects/ideas that arouse curiosity about science subjects by using technology.
19	He/She can evaluate fun activities/projects/ideas on science subjects alone.
20	He/she can evaluate activities/projects/ideas related to science subjects that he/she can specialize on his/her own.
21	He/she can evaluate activities/projects/ideas that arouse curiosity about science subjects alone.
22	He/She can evaluate fun activities/projects/ideas on science subjects with his/her friends.
23	He/she can evaluate activities/projects/ideas related to science subjects that he/she can specialize with his/her friends.
24	He/she can evaluate activities/projects/ideas that arouse curiosity about science subjects with his/her friends.
25	He/She can evaluate fun activities/projects/ideas on science subjects by using technology.
26	He/she can evaluate activities/projects/ideas related to science subjects that he/she can specialize by using technology
27	He/she can evaluate activities/projects/ideas that arouse curiosity about science subjects by using technology.

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