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DESIGN AND IMPLEMENTATION OF A STEM ACTIVITY FOR THE EDUCATION OF STUDENTS WITH MILD INTELLECTUAL DISABILITIES*

HAFİF DÜZEYDE ZİHİNSEL YETERSİZLİĞİ OLAN ÖĞRENCİLERİN EĞİTİMİNDE KULLANILMAK ÜZERE BİR STEM ETKİNLİĞİ GELİŞTİRİLMESİ VE UYGULANMASI

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ABSTRACT

This study aimed to design and implement an activity in which the STEM approach is included in the 5E model for the education of students with mild intellectual disabilities. The case study method was used in the research. Learning outcomes from different sources have been brought together, taking into account student needs in the activity design. After determining aspects such as the activity's duration, methods, and techniques, the application portion of the activity is structured. The engage step started with questions used to attract students' attention, STEM activity was embedded in the exploration step, and necessary explanations were made in line with the learning objectives in the explanation step. In the elaboration phase, sapling planting work was carried out in the school garden with the students. For the evaluation part, the researchers created a "Rating Scale" following the learning objectives. A semi-structured interview form was also created to obtain students' opinions at the end of the STEM activity. When the design for the activity was finally finished, it was implemented at a vocational school that targeted students with mild intellectual disabilities. The study group comprised 8 high school students with mild intellectual disabilities (two females and six males), identified by convenience sampling among the purposeful sampling methods. At the and of this research it was noted that the activity helped the students meet the necessary learning objectives. Semi-structured interviews conducted with the students revealed that they enjoyed and enjoyed the activity. Due to the fact that the STEM approach facilitates the multifaceted development of students, it may be suggested that this approach be used more often in the education of students with mild intellectual disabilities.

Keywords: Individuals with mild intellectual disabilities, photosynthesis, plant cultivation, robotic technologies, STEM.

ÖZ

Bu çalışmanın amacı, hafif düzeyde zihinsel yetersizliği olan öğrencilerin eğitiminde STEM yaklaşımının 5E modeline entegre edildiği bir etkinlik geliştirilmesi, uygulanmasıdır. Araştırmada durum çalışması yöntemi kullanılmıştır. Etkinlik tasarımında öğrenci ihtiyaçları dikkate alınarak farklı kaynaklardan kazanımlar bir araya getirilmiştir. Etkinliğin süresi, kullanılacak yöntem ve teknikler gibi kısımlar belirlendikten sonra, etkinliğin uygulanması kısmı yapılandırılmıştır. Girme basamağı öğrencilerin dikkatini çekmek için kullanılan sorularla başlamış, keşfetme basamağına STEM aktivitesi gömülmüş, açıklama basamağında kazanımlar doğrultusunda gerekli açıklamalar yapılmıştır. Derinleştirme basamağında da öğrencilerle birlikte okul bahçesinde fidan dikme çalışması gerçekleştirilmiştir. Değerlendirme kısmı için kazanımlar doğrultusunda araştırmacılar tarafından "Derecelendirme Ölçeği" geliştirilmiştir. Ayrıca, STEM etkinliği sonunda öğrencilerin görüşlerini almak için yarı yapılandırılmış görüşme formu oluşturulmuştur. Etkinlik tasarımı tamamlandıktan sonra hafif düzeyde zihinsel yetersizliği olan öğrencilerin eğitim aldığı bir meslek okulunda uygulanmıştır. Çalışma grubu, amaçlı örnekleme yöntemlerinden kolay ulaşılabilir örnekleme yöntemiyle belirlenen 8 hafif düzeyde zihinsel yetersizliği olan lise öğrencisidir (2 kız, 6 erkek). Çalışmanın sonunda gerçekleştirilen etkinliğin öğrencilerin ilgili kazanımları elde etmelerine katkı sağladığı görülmüştür. Öğrencilerle gerçekleştirilen yarı-yapılandırılmış görüşmeler etkinlikten hoşandıklarını ve keyif aldıklarını ortaya koymuştur. STEM yaklaşımının öğrencilerin çok yönlü gelişimine olanak sağladığı düşünülürse, hafif düzeyde zihinsel yetersizliği olan öğrencilerin eğitiminde bu yaklaşımın kullanımının artırılması önerilebilir.

Anahtar Kelimeler: Bitki yetiştirme, fotosentez, hafif düzeyde zihinsel yetersizliği olan birey, robotik teknolojiler, STEM.

INTRODUCTION

STEM is an integrated educational approach in which science, technology, engineering, and mathematics disciplines are addressed together (Bybee, 2010). While the holistic integration of STEM disciplines is mentioned in this definition, some researchers argue that STEM can also be defined as the integration of at least two main disciplines (two of science, technology, engineering, and mathematics) in accordance with the interests and experiences of students and teachers (Çorlu, Capraro & Capraro, 2014). According to some studies, the concept originated during the Industrial Revolution (White, 2014). Yet, its usage in education belongs to later periods. In the 1980s, attempts to raise qualified people and keep up with technological and scientific advancements prompted a rise in efforts to develop the quality of science and mathematics education (National Science Foundation [NSF] and U.S. Department of Education, 1980). With the publication of the National Science Education Standard in 1996, the United States adopted research-inquiry-based science education (National Research Council [NRC], 1996). When these educational efforts in the United States were insufficient to compete with developing states in the far east (Akgündüz et al., 2015), an approach emphasizing engineering skills was employed (NRC, 1996). In Europe, STEM strategic plans, STEM projects, STEM reports, curriculum regulations, and STEM competitions have been implemented while this process is ongoing in the United States (Ministry of National Education [MoNE], 2016).

In Turkey, Village Institutes, Science High Schools, and Science and Art Centers (SAC) conduct research for STEM education. During the pre-republican era, Enderun School (a special school in the Ottoman palace) also provided training for this purpose (Kanlı & Özyaprak, 2015). The formation of STEM laboratories within Universities and National Education Directorates, incorporation of STEM education into the strategic plan, teacher training, and project work are the topics of research conducted in Turkey in this field (Ayverdi, 2018). All of these studies target students with normal skill levels. However, individuals with disabilities have a natural right to receive STEM education (Prema & Dhand, 2019). Individuals with disabilities are defined as "those with long-term physical, mental, intellectual, or perceptual impairments that impede their full and effective involvement in society under equal conditions with other individuals." (Assembly, 2006). According to Article 26 of the United Nations Universal Declaration of Human Rights (1948), every person has the right to education. In Article 23 of the Convention on the Rights of the Child (1989), it is highlighted that the state must offer education, vocational training, medical treatment, and rehabilitation services to children with disabilities. Article 24 of the Convention on the Rights of Persons with Disabilities, which was signed on 30 March 2007, underscores that the parties to the convention should be mindful of the principle of equality of opportunity in the education given to disabled people and that opportunities for lifelong learning should be made available by giving priority to the education of disabled people at all levels of education in an integrative and nondiscriminatory manner (UN, 2007).

The principle of equal opportunities in education for people with disabilities mandates that the opportunities granted to students with normal skills must also be available to individuals with disabilities exactly. Therefore, it is essential to provide those with disabilities access to STEM education within the context of equal opportunity. Nevertheless, since the programs designed for students with normal skill levels necessitate language skills, a certain level of literacy, cognitive-conceptual development, psycho-social functionality, and sensory-physical abilities, disabled individuals cannot benefit from or can benefit only marginally from the educational services provided to students with normal skill levels (Scruggs & Mastrubieri, 1993). For this reason, educational opportunities for disabled people that will let them grow in line with their interests and capabilities should be planned by taking into consideration their disability status as well as their level of impairment (MoNE, 2008). In order to facilitate inclusiveness and accessibility in STEM, educators need individualized programs that personalized curricula according to students' disability situations and needs (Prema & Dhand, 2019).

Intellectual disability is one of the disabilities that individuals may have. Due to their shortcomings or restrictions in their social, conceptual, and practical abilities, which differ from those of individuals with ordinary intelligence in terms of mental functions, people with intellectual disability are individuals who need special education (MoNE, 2010). This disability of individuals with intellectual disability can be mild, moderate, severe, or very severe (MoNE, 2018). To ascertain each person's educational needs and do the necessary research, it is critical to determine their level of disability (Tosun, 2019). Special Education Vocational Schools are one of the educational establishments in Turkey that can provide an education to students who have mild intellectual disabilities. When the timetable for the education that is provided to the students in these schools is investigated, it is discovered that the curriculum includes courses in Turkish, mathematics, social life, religious culture and ethics, music, visual arts, physical education, guidance, social, cultural, and athletic activities, as well as business education and professional ethics. It is clear to see that traditional approaches take center stage in these courses' curricula. Yet, innovative approaches like STEM have been demonstrated to be successful in improving the day-to-day quality of life for students with disabilities (So et al., 2021). Researchers have recommended incorporating art into STEM education (STEM+A=STEAM), based on the occasional finding that students with intellectual disability were disappointed by their failures in STEM disciplines. Thus, using art in the teaching process can increase the motivation of students to learn difficult subjects. In contrast to disciplines that force students to reach a given point in a certain amount of time, the self-expression and creativity of students in the art may be very effective in encouraging the development of individuals with intellectual disabilities. Additionally, art is essential in helping students with disabilities to explore an abstract world. Therefore, art-based activities may be used to assist STEM education for students with disabilities (Hwang & Taylor, 2016).

Teachers should adapt content, method, or product in STEM activities for students with intellectual disabilities based on variations in students' readiness, interest, and/or learning profiles, whether art is integrated. In other words, the stem approach to teaching students with intellectual disabilities calls for teachers to adapt their lesson plans and teaching strategies slightly for this student population (Obi, 2014). To use this strategy in the education of individuals who have intellectual disabilities, teachers need exemplary practices in this field. In the literature, while the STEM applications performed at the normal skill level or with gifted students (Almarode et al., 2014; Ayverdi, 2018; Ayverdi et al., 2020; Baran et al., 2015; Barış & Ecevit, 2019; Burt, 2014; Ceylan, 2014; Cotabish et al., 2013; Dieker et al., 2012; Ercan, 2014; Gülen, 2016; Gülhan & Şahin, 2016; Güneş & Karaşah, 2016; Ihrig et al., 2018; Irkıçatal, 2016; Keçeci et al., 2017; Kim & Choi, 2012; Kim et al., 2017; Koç, 2017; Koyuncu & Kırgız, 2016; Özçelik & Akgündüz, 2018; Pabuçcu Akiş & Demirer, 2022; Robinson et al., 2014; Salman-Parlakay, 2017; Willis, 2017; Yamak et al., 2014; Yasak, 2017; Yıldırım & Altun, 2015; Yıldırım & Selvi, 2017; Yıldız et al., 2017; Yoon, et al., 2014; Young et al., 2017), the studies conducted with individuals who have intellectual disabilities are quite limited in number. In a study titled barrier-free STEM (Bülbül & Sözbilir, 2017) on STEM applications with disabled people, it was noted that applications designed with disabled students' skills in mind were necessary.

It was briefly discussed how STEM education should be adapted for groups with different disabilities. The necessity of providing students with disabilities with rich materials that may be used in STEM education was underlined, and the concepts of STEM literacy and elaborate STEM education were addressed. A brief mention is also made of barrier-free approaches to measurement, career planning and personal development, and remote mentoring methods for students with disabilities. In order to increase students' stem knowledge and achievement, Hwang and Taylor (2016) proposed a framework for STEM education with disabled students and recommended the incorporation of art. Obi (2014) argued that students with intellectual disabilities should receive a STEM education that is differentiated. Davis (2014) proposed an approach called UDL (Universal Design for Learning) for STEM education provided to individuals with disabilities.

The Significance and Purpose of the Study

It was revealed that a significant portion of the studies reviewed in the literature contained theoretical data on STEM education for individuals with disabilities. In an applied study involving STEM activities with individuals with mild intellectual disabilities (Tosun, 2019), the implications of simplified STEM education with eighth-grade students with mild mild intellectual disabilities on participation levels in the course, changes in their interest in a science course, and variations in their attitudes towards science course were investigated. One of the few application studies in the literature is Tosun's (2019) study. Yet, for teachers who work in this area, there is a need to raise the number of practical studies. In terms of providing an example of a STEM activity that may be utilized with individuals with mild intellectual disabilities, this study is also regarded to be beneficial for teachers who work in this field. In this context, this study aims to design and implement an activity in which the STEM approach is included in the 5E model for the education of students with mild intellectual disabilities.

Learning Objectives

The activity is an application that allows students to learn by doing and living, and it is meant to cater to the educational requirements of students who have mild intellectual disabilities. In practice, the STEM approach was integrated into the 5E model. This research was conducted for the "Agriculture" main field, "Garden Plants/Horticulture" branch "Planting" module of the curriculum for students with mild intellectual disabilities. Some of the learning objectives were collected from the corresponding module, while others were retrieved from the Next Generation Science Standards (NGSS). Taking into consideration the skills determined in the "Partnership for 21st Century Learning", 21st-century skills were created in the activity (Partnership for 21st Century Learning, 2011). Engineering learning objectives were selected from the Next Generation Science Standards-NGSS (NRC, 2013). In developing the activity, the Common Core State Standards (CCSS) in which NGSS standards are linked were also considered. NGSS, Partnership for 21st Century Learning and CCSS learning objectives were also used in the activity design since it was aimed to develop an learning activity in international standards. The

Information Technologies-related learning objectives were derived from the Information Technologies field's learning objectives for students with mild intellectual disabilities. The activity's learning objectives are given in Table 1.

Table 1

Activity learning objectives

NGSS Performance Expectation	CCSS Standard	ISTE standards for students	Science	Technology	Engineering
Develop a model to illustrate the role of photosynthesis and cellular respiration in the cycling of carbon among the biosphere, atmosphere, hydrosphere, and geosphere (HS-LS2-5). Develop a model to generate data for iterative testing and modification of a proposed object, tool, or process such that an optimal design can be achieved (MS-ETS1-4).	Reason abstractly and quantitatively. (MP.2).	Students articulate and set personal learning goals, develop strategies leveraging technology to achieve them, and reflect on the learning process itself to improve learning achievements (1.1. Empowered Learner, 1.1.a) Students know and use a deliberate design process for generating ideas, testing theories, creating innovative artifacts, or solving authentic problems (1.4 Innovative Designer, 1.4.a) Students publish or present content that customizes the message and medium for their intended audiences (1.6 Creative Communicator, 1.6.d)	1. Recognizes the tools used in planting. 2. Refers to the processes involved in the planting of seedlings. 4. Digs a pit with a shovel. 5. Fills the pit with fertilizer using a shovel. 6. Cleans the seedling roots with pruning shears. 7. Places the seedling in the planting pit. 8. Compresses the soil around the seedling. 9. Realizes the significance of photosynthesis in plants' capability to produce food. 10. Realizes the importance of the natural environment for living beings.	1. Uses new technologies. 2. Develops skills regarding the use of technological products, processes, and systems. 3. Establishes a connection between software and hardware.	Creates models for the solutions.

METHOD

This study aims to design and implement an activity in which the STEM approach is included in the 5E model for the education of students with mild intellectual disabilities. This research is modeled based on a case study design. A case study is a research design that involves an in-depth exploration and analysis of a specific instance or situation within its real-life context. It aims to provide a comprehensive understanding of the complexities and dynamics of the chosen case, often utilizing multiple data sources and methods to generate insights and draw meaningful conclusions (Patton, 2014). Case studies are commonly employed in various academic disciplines to investigate phenomena, develop theories, or examine specific issues within a bounded system (Büyüköztük et al., 2010).

Participants

The activity was carried out with 8 high school students with mild intellectual disabilities (2 females, and 6 males). The activity took place in a vocational school in Turkey affiliated with the state that educates students with mild intellectual disabilities. The students were 10th-grade students. Their readiness was suitable for the activity. The activity was applied as 6 class hours (6x40 minutes).

Data Collection Tools

Semi-structured interview form. A semi-structured interview form was developed by the researchers to obtain the opinions of the students at the end of the STEM activity. After the questions planned to be included in the form were written, they were examined by three field experts, and necessary arrangements were made in the questions in line with the suggestions. It was emphasized that the questions should be clear, short, and concise so that they could be easily understood by these students as much as possible. The interviews were conducted by one of the researchers in an environment in which the guidance counselor also participated, and each interview lasted approximately 15-20 minutes.

Rating scale. The researchers developed a rating scale for use in the evaluation step at the end of the activity. Expert opinions were obtained on whether the rating scale was appropriate for the level of the participants, and it was applied to the students after the necessary arrangements were made. The learning objectives in the activity were taken into consideration in the creation of the rating scale. Each learning objective was considered as an item and a rating scale was created to include all learning objectives and content validity was ensured. Consisting of 19 items, the highest score that students can obtain from the "Rating Scale" is 76.

Materials

Computer, mBot robotic kit, crayons, glue, scissors, colorful cardboard, other decorations, balloon, pin, seedling, glove, seedling, bucket strainer.

Procedures

The STEM acitivity was developed for the "Planting" module of the "Agriculture" main field, "Horticulture" branch. Some of the learning objectives were taken from the relevant module and some were taken from the NGSS, CCSS, and ISTE standards for students. After determining the duration of the activity and the methods and techniques to be used, the implementation part of the activity was structured. For the evaluation part, a "Rating Scale" was developed by the researchers in line with the learning objectives.

The activity was designed in accordance with 5E learning model. The 5E learning model is an instructional framework that consists of five phases: Engagement, Exploration, Explanation, Elaboration, and Evaluation. This model is based on a constructivist learning approach, offering a variety of possibilities for both learners and instructors (Ulukaya Öteleş, 2020). It emphasizes student-centered learning and knowledge construction, allowing students to be more autonomous in their learning process and increasing their engagement and interest in the subject matter (Lasaiba, 2023; Resmol & Leasa, 2022; Wiriani & Ardana, 2022).

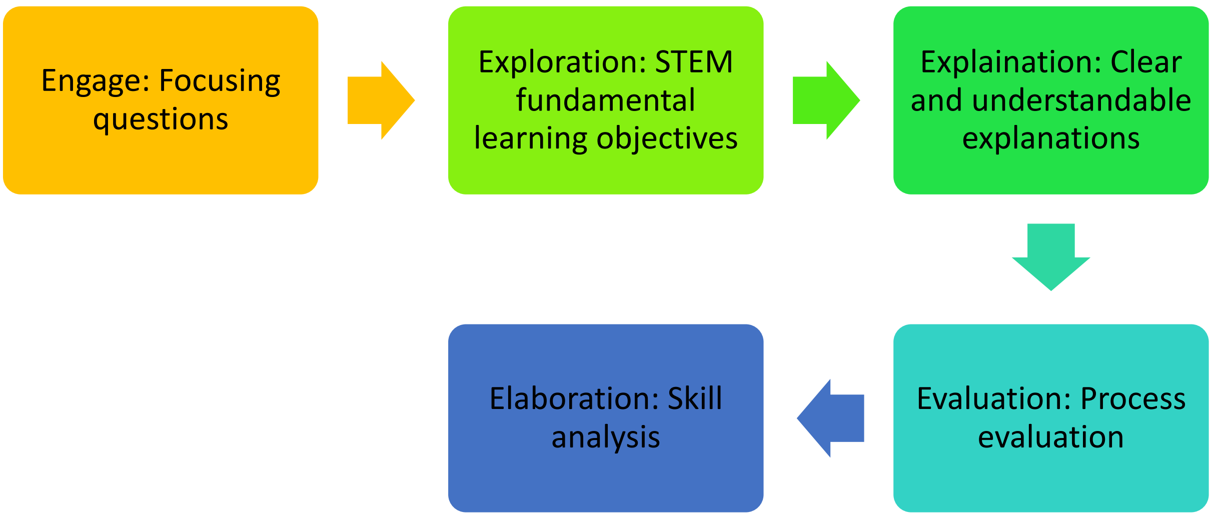

Figure 1. Learning activity design process

In the design of the activity, a collaborative effort was made involving an expert in science education, an information technologies specialist, and a special education expert. At the engage stage, questions were formulated to capture students' attention and assist them in focusing on the subject. In determining these questions, consideration was given to students' varying levels of ability, and care was taken to ensure that the questions were suitable for engaging students in the activity.

In the exploration stage, a tailored approach was adopted, taking into account the fundamental learning objectives in science, engineering, and technology, aligned with the students' proficiency levels. To ensure the appropriateness of the planned activity for students, learning profiles, readiness levels, and areas of interest were considered. In the explanation stage, efforts were made to construct sentences that are as simple as possible, using clear and understandable language for explanations. During the elobaration stage, a tree-planting activity was planned, heavily emphasizing psychomotor skills.

This study takes into consideration the steps of skill analysis based on the principle of guiding students to perform tasks step by step. Skill analysis, frequently employed in special education, relies on breaking down complex skills into smaller steps for effective teaching. The evaluation stage is also designed to be evaluated through the use of a rating scale, allowing for the assessment of the process.

After the STEM activity design was finalized, it was implemented in a vocational school where students with mild intellectual disabilities received education. A guide teacher, well acquainted with the students in the study group, was present with them during our activity. During the implementation of the activity, questions that would attract students' attention and connect the topic to plants were asked in the engage step. In the exploration step, the students were divided into two groups and given the mBot robotic kit, scissors, crayons, glue, colored cardboard, various ornaments, pins, and balloons. Using these materials, the students created tree figures on the robot and mounted the pin on the robot in a suitable manner. The balloons were inflated and "carbon dioxide" was written on each balloon. The balloons were also mounted on the back of the robot to avoid hindering its movement. Thus, it was ensured that they completed their designs such that each robot would have a pin, balloon, and tree figure on it (See Figure 4).

Afterwards, the students were asked to popped the balloon-labeled carbon dioxide with robots containing tree figures in groups. The robot that popped the most carbon dioxide balloons won this competition. In the explanation step, the work carried out with the robotics kit is explained, and photosynthesis is discussed. After mentioning the importance of photosynthesis for living organisms, the necessity of plants for this event and the importance of growing plants were emphasized. In the elaboration step, the work carried out by the students who planted saplings during the process was examined using a rating scale in the evaluation step.

FINDINGS

Findings Regarding the Implementation of the STEM Activity

The activity was designed and implemented in accordance with 5E. These phases include engage, explore, explain, elaborate, and evaluate.

Engage stage. During the engage stage of the activity's implementation, questions were posed that would draw the students' attention and link the topic to the plants.

- Do you enjoy spending time in nature?
- What do you do when you are in nature?
- How do you feel when you are in nature?
- Which living and nonliving things are drawing your attention? Why?
- Which organisms do you see most often in nature? What importance may these organisms have in your life?

Exploration stage. A study was conducted with students in the exploration stage to comprehend the significance of plants for living things. For this purpose, the students were divided into groups of two. A mBot robotics kit, scissors, crayons, glue, colored cardboard, different decorations, a pin, and a balloon were given to each group. Using these materials, students were facilitated to create tree figures on the robot, as well as to mount the pin on the robot appropriately. After the balloons had been inflated, each student was instructed to write "carbon dioxide" on their balloon. The balloons are also put on the robot's back in a form that does not hinder its movement. Thus, each robot is designed to have a pin, balloon, and tree figure.

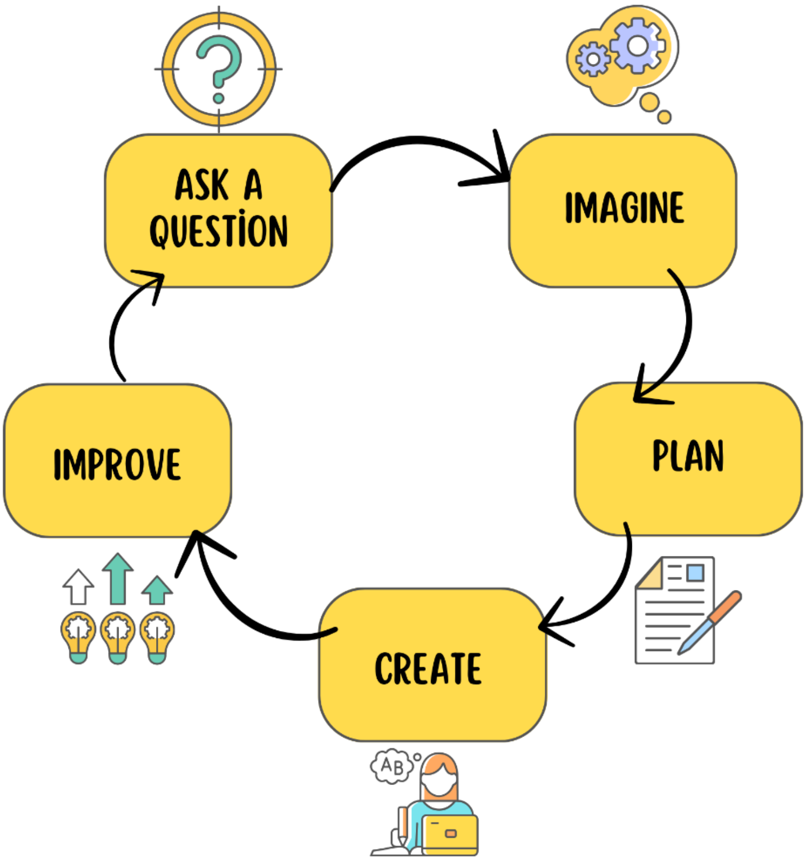

Figure 2. Engineering design process

In this stage, the STEM activity was conducted in accordance with the engineering design process steps (ask-imagine-plan-create-improve) (See Figure 2). The first step involves defining the problem, aiming to raise students' awareness of the issue. In the second step, students are given the opportunity to think about solutions. During the planning stage, the third step, students engage in discussions to plan their approach. In the fourth step, students implement their plans, and in the final stage, they refine their designs.

Figure 3. Teachers and students working on robot design

Figure 4. An example of robotic design process

When it came to the designing part of the project, students were strongly encouraged to think creatively. Each group that has finished their design presented it to the other groups. During this presentation, students were given the opportunity to discuss what aspects of the design they focused on paying attention to, as well as how they determined where the pin and balloon should be installed.

Figure 5. Students performing the study and robot designs

Then, the students try to blow up the balloons that have carbon dioxide written on them with the other robots that have tree figures on them after being divided into groups. The robot that popped the most carbon dioxide balloons won the competition.

Explanation Stage. During the explanation stage, the students were probed about how they might explain the robots that had the tree figure blowing the balloons that had the carbon dioxide written on them. After the opinions of the students were collected, it was shown that the plants used carbon dioxide and water to carry out the process of photosynthesis, which resulted in the production of nutrients and oxygen. It was stated that they conducted research to determine how trees in robots remove carbon dioxide from the atmosphere with this activity, similar to photosynthesis. Plants are essential to the survival of other organisms.

After discussing the need of protecting plants, the value of cultivating plants was emphasized. It was suggested that by planting seedlings, the number of plants may be increased. Tools and equipment used for planting seedlings were introduced to the students. The students were instructed on how to plant seedlings and informed that they would repeat these steps. It was said that a pit would be formed with a shovel and then filled with fertilizer. It was informed that after trimming the seedling's roots using pruning shears, they were put in the planting pit. The process was finished by pressing the soil around the plant and watering the soil.

Elaboration Stage. At the elaboration step, dibbling was carried out with the students. Here, the teacher first showed the procedures to be performed, then ensured that the students followed those steps correctly. Students were able to concentrate on their tasks and finish the process steps within the time allocated. In addition, the teacher was attentive to occupational safety and provided the students with the necessary caution. Among the matters to be taken into account were the economical use of materials and equipment as well as the cleanliness of the environment.

The teacher dug a hole with a shovel and put fertilizer in the pit. The students did the same thing. The seedlings were inserted into the planting pit after having their roots pruned using pruning shears. It allowed students to do the same carefully. The teacher pressed the soil around the seedling and gave water to the soil. It also made it possible for students to appropriately carry out the steps.

Figure 6. While students plant seedlings

Figure 7. While students water seedlings

Evaluation Stage. In the evaluation stage, students were asked open-ended questions regarding the task they completed during the process, and their learning objectives were assessed using a rating scale by the teacher. The items in the rating scale are as follows:

- Recognizes the significance of photosynthesis in plant nutrition production.
- Designs a model for photosynthesis.
- Uses new technologies
- Develops skills regarding the use of technological products, processes, and systems
- Establishes a connection between software and hardware
- Tries new approaches for innovation
- Recognizes the tools used in planting
- Refers to the processes involved in the planting of seedlings
- Digs a pit with a shovel
- Cleans the seedling roots with pruning shears
- Places the seedling in the planting pit
- Compresses the soil around the seedling
- Focuses on the task while working
- Observes occupational safety precautions while working
- Uses tools and materials economically
- Complies with the sanitary rules of the working environment
- Completes his/her task within the given time
- Collaborates with group friends to achieve the goal
- Shares/presents thoughts, questions, ideas, and solutions

Findings Regarding the Semi-structured Interviews and the Rating Scale

Students with mild intellectual disabilities experienced an activity based on the STEM approach during this activity and worked in teams for the division of labor. Semi-structured interviews performed with the students at the end of the activity revealed that they enjoyed the activity. First of all, when the students were asked whether they had previously participated in works related to nature, S1(male) stated that she had previously participated in planting saplings with her classmates, S5(male) stated that he had previously participated in planting saplings in a burnt forest area with his friends, and S3(female) stated that she had previously participated in activities related to nature in other provinces and other schools. When questioned about how it felt to participate in such an activity with their classmates, S8(male)stated that she noticed that she felt good, was happy and everyone was happy. S7 (male) said that he especially enjoyed the part where he worked with robots, and that blowing up the trees in his robot and the carbon dioxide balloons in his friends' robots was very fun for them. He said that being successful made him feel good. All of the students responded positively when asked whether they would be interested in taking part in such an activity if it were to be organized again. When the students were questioned about if their perspective on nature has changed as a result of this activity, S2 (male) said that spending time with the soil and touching the earth has always made him feel good, and he appreciated this activity even more. S4(female) explained her thoughts as follows;

> "In this activity, I understood what photosynthesis is and it is important to protect nature. It's crucial to avoid harming plants and animals. Because it is wrong to harm animals and trees. It is crucial to preserve nature since it is home to both living and non-living organisms."

Considering the student evaluations, it is feasible to conclude that the goal of the study was accomplished.

The teacher used a "Rating Scale" consisting of 19 items to evaluate the students' learning objectives related to the activity. The group's mean score on the "Rating Scale" was determined to be 71.25, meanwhile, the highest possible score was 76. Considering that each item is evaluated with a 4-point rating scale, the students' average is 3.75. This shows that the students achieved a significant part of the learnin objectives during the activity process. Students gained knowledge about plant cultivation in agriculture, photosynthesis in science, the use of innovations in technology and engineering through this activity.

DISCUSSION and CONCLUSION

Considering the student evaluations, it is feasible to conclude that the goal of the study was accomplished. In the literature, it has been determined that activities with students with mild intellectual disabilities increase their motivation and interest in the course as well as favorably alter their attitudes (Tosun, 2017). Similar findings show that STEM-related activities improve students' attitudes, motivation, and interests in both gifted students and those with normal skill levels (Almarode et al., 2014; Bozkurt, 2014; Burt, 2014; Ceylan, 2014; Dieker et al., 2012; Ercan, 2014; Gülen, 2016; Gülhan & Şahin, 2016; Ihrig et al., 2018; Irkıçatal, 2016; Kim & Choi, 2012; Koç, 2017; Özdoğru, 2013; Pabuçcu Akiş & Demirer, 2022; Pekbay, 2017; Salman-Parlakay, 2017; Willis 2017; Yamak et al., 2014; Yasak, 2017; Yıldırım & Altun, 2015; Yıldırım & Selvi, 2017).

In current study, the students' remarks demonstrate that they gained a positive attitude, motivation, and interest in the course. Çevik and Üredi (2016) discovered that students with mild intellectual disability improved their academic achievement in a life science education course and developed a positive attitude towards the course. The students with mild intellectual disability experienced more successful postschool outcomes, including being employed and attending postsecondary education, which could indicate a positive attitude and motivation towards their academic pursuits (Bouck & Chamberlain, 2017). Göktaş and Yazici (2020) found that instructing students with mild intellectual disabilities in problem-solving strategies enhances their problem-solving skills and influences the problem-solving process, a crucial element in STEM education.

While developing activities for students with mild intellectual disabilities in this research, careful consideration was given to the students' interests and skills. It is essential to take into account the varying awareness levels and deficits of students with disabilities while designing STEM activities for these students in terms of the activities' efficacy (Bülbül & Sozbilir, 2017). In the activity conducted for this research, taking into consideration the interests and skills of the students, the part on robots focused less on software and more on the creation of fiction featuring robots working in order to fulfill a task. In addition, one of the most significant components of STEM education is having a solid understanding of the students' individual strengths and weaknesses, as well as enabling students to collaborate based on these traits (Bülbül & Sözbilir, 2017; Hwang & Taylor, 2016; Tosun 2019).

During our activity, a guide teacher who is well familiar with the students in the study group was there with them. In the activities conducted with students with mild intellectual disabilities, it may be advisable to locate a teacher who can assist each of the study groups alongside the school counselor. Since STEM activities are practice-based and students' motor skills are limited, it has been noticed that they need assistance throughout the activity process. Teachers play a pivotal role in ensuring that students with mild intellectual disabilities have access to the general education curriculum (Hord & Xin, 2015). Furthermore, it has been emphasized that teachers need to guide autonomy for students with mild intellectual disabilities, indicating the importance of their role in fostering independence and self-determination among these students (Efendi, 2019). In the context of specific subjects, such STEM areas, teachers have been found to play a significant role in supporting students with mild intellectual disabilities as they advance through the curriculum and face potential struggles with complex concepts (Hord et al., 2021). While it is important to guide students with mild mental disabilities during STEM activities, mentoring is also important in directing them to STEM professions. The study by Sowers et al. (2016) provides valuable insights into the impact of a STEM mentor intervention on youth with disabilities. This research experimentally evaluates the effects of a Science, Technology, Engineering, and Mathematics (STEM) mentoring program on individuals with disabilities, shedding light on the potential benefits of STEM activities for this population.

The students also collaborated in this STEM course. The fact that the item relating to collaboration receives the highest score on the portion of the Rating Scale completed by the teacher is indicative of this situation. From now on, it may be advised to emphasize collaboration in STEM activities including students with mild intellectual disabilities. Because observations made throughout the activity process indicate that students with mild intellectual disabilities enjoy collaborating and are eager to work together. Hord (2023) briefly reviewed studies on the math teaching of secondary school students with mild intellectual disabilities, indicating the potential for collaboration and enjoyment in learning. Additionally, The students with identified special needs, including those with mild intellectual disabilities, benefit from collaboration, leading to improved achievement and interest in learning (Roldán-Álvarez et al., 2021). This suggests that collaboration can foster an environment where students with mild intellectual disabilities enjoy working together.

According to Çil and Çepni (2017), the evaluation of STEM activities conducted with students with mild intellectual disabilities should be centered on the students' performance, consider their disability, and measure the students' interests, motivation, etc. In the evaluation part of the activity conducted within the scope of the research, the affective features, performances, and individual differences of the students were also considered. It may be advised moving forward to create the scale tool with a focus on various elements when assessing STEM activities that will be carried out with students who have mild intellectual disabilities.

The results of the research revealed that the students enjoyed participating in the activity, planting saplings made them feel good, and the robotic part created a sense of accomplishment. In this context, it can be said that the study has affective learning objectives for the students. The results obtained from the rating scale prepared for the students' achievements regarding the course also showed that the learning objectives were achieved to a significant extent. Since the rating scale includes learning objectives related to the cognitive field, it can be said that the activity contributed to the achievement of cognitive learning objectives. In the activity, students used their motor skills to plant saplings, design robots and move the robots they designed. This can be interpreted as contributing to the development of the psychomotor domain in terms of the coordinated use of motor muscles. In this context, this activity, which is carried out with students with mild mental disabilities, is important in terms of contributing to the students' cognitive, affective and psychomotor development. Therefore, it can be used to contribute to the versatile development of students with mild mental disabilities.

SUGGESTIONS

Based on the results of the current study, the following recommendations have been developed:

1. The presence of a guidance counselor who knows the students well has facilitated the process in the current activity. It is suggested that for STEM activities involving students with mild intellectual disabilities, having a guidance counselor who is familiar with these students can be beneficial.
2. Students expressed enjoyment in collaborating during STEM activities. For future STEM activities designed for students with mild intellectual disabilities, emphasizing collaboration can be recommended.
3. In the design of the activity, it was observed that there is a limited number of STEM activities specifically prepared for students with mild intellectual disabilities. Considering the benefits of STEM activities for these students, it is suggested to design STEM activities tailored to students with mild intellectual disabilities.
4. Within the scope of this study, an activity was developed for the "Agriculture" main field, the "Garden Plants" branch, and the "Planting" module. It is recommended to conduct various STEM activities with different learning outcomes.
5. The mBot robotic technology was used in this activity. For future STEM activities designed for students with mild intellectual disabilities, it is suggested to explore the use of different technologies and investigate their effects.
6. This study was structured as a case study. For future research, planning experimental and mixed-methods studies is recommended.

REFERENCES

Akgündüz, D., Aydeniz, M. Çakmakçı, G. Çavaş, B. Çorlu, M. S., Öner, T. & Özdemir, S. (2015). *FeTeMM eğitimi Türkiye raporu: Günün modası mı yoksa gereksinim mi? [STEM education Turkey report: Today's fashion or necessity?].* Scala Press.

Almarode, J. T., Subotnik, R. F., Crowe, E., Tai, R. H. Lee, M. G., & Nowlin, F. (2014). Specialized high schools and talent search programs: Incubators for adolescents with high ability in STEM disciplines. *Journal of Advanced Academics, 25*(3), 307-331. https://doi.org/10.1177/1932202X14536566

Assembly, U. G. (2006). Convention on the Rights of Persons with Disabilities, 2006. *Retrieved on*, *1*, 07-16.

Ayverdi, L. (2018). *Özel yetenekli öğrencilerin fen eğitiminde teknoloji, mühendislik ve matematiğin kullanımı: STEM yaklaşımı [Usage of technology, engineering and mathematics in science education for gifted students: STEM approach]* [Unpublished doctoral dissertation]. Balıkesir University.

Ayverdi, L., Avcu, Y. E., Ülker, S., & Karakış, H. (2020). Bilim ve sanat merkezlerinde aile katılımıyla gerçekleştirilen bir fetemm etkinliğinin uygulanması ve değerlendirilmesi. *Araştırma ve Deneyim Dergisi*, *5*(1), 24-36.

Baran, E., Canbazoğlu-Bilici, S., & Mesutoğlu, C. (2015). Science, technology, engineering, and mathematics (STEM) public service announcement(psa) development activity. *Journal of Inquiry Based Activities (JIBA), 5*(2), 60-69.

Barış, N., & Ecevit, T. (2019). STEM education for gifted student. *Necatibey Faculty of Education Electronic Journal of Science and Mathematics Education, 13*(1), 217-233. https://doi.org/10.17522/balikesirnef.529898

Bouck, E. C., & Chamberlain, C. (2017). Postschool services and postschool outcomes for individuals with mild intellectual disability. *Career Development and Transition for Exceptional Individuals*, *40*(4), 215-224.

Bozkurt, E. (2014). *Mühendislik tasarım temelli fen eğitiminin fen bilgisi öğretmen adaylarının karar verme becerisi, bilimsel süreç becerileri ve sürece yönelik algılarına etkisi [The effect of engineering design based science instruction on science teacher candidates' decision making skills, science process skills and perceptions about the process]* [Unpublished doctoral dissertation]. Gazi University.

Burt, S. M. (2014*). Mathematically precocious and female: Self-efficacy and STEM course choices among high achieving middle grade students.* [Unpublished doctoral dissertation]. Trevecca Nazarene University School of Education.

Bülbül, M. Ş., & Sözbilir., M. (2017). Engelsiz STEM eğitimi [Kuramdan uygulamaya STEM+E+A eğitimi]. S. Çepni (Eds.), In *Kuramdan uygulamaya STEM+E+A eğitimi* [STEM+E+A education from theory to practice] (p. 511-537). Pegem Akademi.

Büyüköztürk, Ş., Kılıç-Çakmak, E., Akgün, Ö., Karadeniz, Ş., & Demirel, F. (2008). *Bilimsel araştırma yöntemleri*. PegemA Yayıncılık.

Bybee, R. W. (2010). What is STEM education?. *Science*, *329*(5995), 996-996.

Ceylan, S. 2014. *Ortaokul fen bilimleri dersindeki asitler ve bazlar konusunda fen, teknoloji, mühendislik ve matematik (FeTeMM) yaklaşımı ile öğretim tasarımı hazırlanmasına yönelik bir çalışma [A study for preparing an instructional design based on science, technology, engineering and mathematics (STEM) approach on the topic of acids and bases at secondary school science course]* [Unpublished master dissertation]. Uludağ University.

Cotabish, A., Robinson, A., Dailey, D., & Hughes, G. (2013). The effects of a STEM intervention on elementary students' science knowledge and skills. *School Science and Mathematics, 113*(5), 215-226. https://doi.org/10.1111/ssm.12023

Çevik, M., & Üredi, F. (2016). Effects of the project-based learning on academic achievement and attitude of students with mild intellectual disability in life science course. *International Journal of Learning and Teaching*, *8*(2), 90-99.

Çil, E., & Çepni, S. (2017). STEM eğitiminde ölçme değerlendirme. *Pegem Atıf İndeksi*, 541-589.

Çorlu, M. S., Capraro, R. M., & Capraro, M. M. (2014). Introducing STEM education: implications for educating our teachers for the age of innovation. *Education and Science*, *39*(171), 74-85.

Davis, K. E. B. (2014). The need for STEM education in special education curriculum and instruction. *STEM Education: Strategies for teaching learners with special needs*, 1-20.

Dieker, L., Grillo, K., & Ramlakhan, N. (2012). The use of virtual and simulated teaching and learning environments: Inviting gifted students into science, technology, engineering, and mathematics careers (STEM) through summer partnerships. *Gifted Education International, 28*(1), 96–106. https://doi.org/10.1177/0261429411427647

Efendi, J. (2019). The development of guidance counselling program through teaching and learning activities for improving self-determination of students with intellectual disability. *Journal of ICSAR*, *3*(1), 58-61.

Ercan, S. (2014). *Fen eğitiminde mühendislik uygulamalarının kullanımı: Tasarım temelli fen eğitimi [The usage of engineering practices in science education: Design based science learning]* [Unpublished doctoral dissertation]. Marmara University.

Göktaş, O., & Yazıcı, E. (2020). Effectiveness of Teaching Mathematical Problem-Solving Strategies to Students with Mild Intellectual Disabilities. *Turkish Journal of Computer and Mathematics Education (TURCOMAT)*, *11*(2), 361-385.

Gülen, S. (2016). *Fen-teknoloji-mühendislik ve matematik disiplinlerine dayalı argümantasyon destekli fen öğrenme yaklaşımının öğrencilerin öğrenme ürünlerine etkisi [Argumentation science learning approach based on the science-technology-engineering and mathematics disciplines impacts of student learning products]* [Unpublished doctoral dissertation]. Ondokuz Mayıs University.

Gülhan, F., & Şahin, F. (2016). The effects of science-technology-engineering-math (STEM) integration on 5thgrade students' perceptions and attitudes towards theseareas. *International Journal of Human Science 13*(1), 602-620. https://doi.org/10.14687/ijhs.v13i1.3447

Güneş, H., & Karaşah, Ş. (2016). The studies in science education from the past to the present and the importance of science education. *Journal of Research in Education and Teaching, 5*(3),122-136.

Hwang, J., & Taylor, J. C. (2016). Stemming on STEM: A STEM education framework for students with disabilities. *Journal of Science Education for Students with Disabilities*, *19*(1), 39–49.

Hord, C. (2023). Middle and high school math teaching for students with mild intellectual disability. *Support for Learning*, *38*(1), 4-16.

Hord, C., Koenig, K., Zydney, J. M., DeJarnette, A. F., Gibboney Jr, D. P., & McMillan, L. A. (2021). Students with mild intellectual disability engaging in proportions word problems. *Journal of Intellectual Disabilities*, *25*(4), 680-694.

Hord, C., & Xin, Y. P. (2015). Teaching area and volume to students with mild intellectual disability. *The Journal of Special Education*, *49*(2), 118-128.

Ihrig, L. M., Lane, E. L., Mahatmya, D., & Assouline, S. G. (2018). STEM Excellence and leadership program: increasing the level of stem challenge and engagement for high-achieving students in economically disadvantaged rural communities. *Journal for the Education of the Gi*fted, *41*(1), 24–42. https://doi.org/10.1177/0162353217745158

Irkıçatal, Z. (2016*). Fen, teknoloji, mühendislik ve matematik (FeTeMM) içerikli okul sonrası etkinliklerin öğrencilerin başarılarına ve FeteMM algıları üzerine etkisi [STEM related after - school program activities and associated outcomes on students success and on their stem perception and interest]* [Unpublished master dissertation]. Akdeniz University.

Kanlı, E., & Özyaprak, M. (2015). STEM Education for gifted and talented students in Turkey. *Journal of Gifted Education Research, 3*(2), 1-10.

Keçeci, G., Alan, F., & Kırbağ-Zengin, B. (2017). Science festival attitude scale: validity and reliability study. *International Journal Of Eurasia Social Sciences , 8*(27), 562-575.

Kim, G. S., & Choi, S.Y. (2012). The effect of creative problem solving ability and scientific attitude through the science based STEAM program in the elementary gifted students. *Elementary Science Education*, *31*(2), 216-226. https://doi.org/10.15267/keses.2012.31.2.216

Kim, M., Cross, J., & Cross, T. (2017). Program development for disadvantaged high-ability students. *Gifted Child Today, 20*(2), 87-95. https://doi.org/10.1177/1076217517690190

Koç, Y. (2017). *Fen bilimleri dersinde STEM eğitim modeli yaklaşımı kullanarak genç mekatronikcilerin yetiştirilmesi [Growing young mechatronics by using stem education model approach in science course]* [Unpublished master dissertation]. Gelişim University.

Koyuncu, A., & Kırgız, H. (2016). The effect of science centers on students' achievements in international examinations. *Journal of Research in Informal Environments (JRINEN), 1*(1), 52-60.

Lasaiba, M. A. (2023). The effectiveness of the 5E learning cycle model as an effort to optımize students' activities and learning outcomes. *Edu Sciences Journal*, *4*(1), 11-21.

Ministry of National Education (MoNE). (2008). *Özel eğitimde fen ve doğa etkinlikleri [Science and nature activities in special education].* Ministry of National Education. http://www.cahilim.com/pdf/cocuk/ozel-egitimde-fen-ve-doga-etkinlikleri.pdf

Ministry of National Education (MoNE). (2010). *Neden, nasıl, niçin kaynaştırma [Why, how, why inclusive education].* Ministry of Education. orgm.meb.gov.tr/alt_sayfalar/yayimlar/kaynastirma/kaynastirma.pdf

Ministry of National Education (MoNE). (2016). *STEM eğitimi raporu [STEM education report*]. SESAM Grup Press.

Ministry of National Education (MoNE). (2018). Özel eğitim hizmetleri yönetmeliği. MEB Özel Eğitim ve Rehberlik Hizmetleri Genel Müdürlüğü.

National Research Council (NRC). (1996). *National science education standards*. National Research Council http://www.csun.edu/science/ref/curriculum/reforms/nses/nses-complete.pdf.

National Research Council. (2013). Next generation science standards: For states, by states.

National Science Foundation & Department of Education. (1980). Science & Engineering Education for the 1980's and Beyond. (NSF Publication No.80-78). Washington, DC: U.S. Government Printing Office.

Obi, S. O. (2014). Working with learners with cognitive disabilities in STEM. *STEM education: Strategies for teaching learners with special needs*, 37-48.

Özçelik, A. & Akgündüz, D. (2018). Evaluation of gifted/talented students' out-of-school STEM education. *Trakya University Journal of Education Faculty, 8*(2),334-351. https://doi.org/10.24315/trkefd.331579

Özdoğru, E. (2013). *Fiziksel olaylar öğrenme alanı için lego program tabanlı fen ve teknoloji eğitiminin öğrencilerin akademik başarılarına, bilimsel süreç becerilerine ve fen ve teknoloji dersine yönelik tutumlarına etkisi [The effect of lego programme based science and technology education on the students' academic achievement, science process skills and their attitudes toward science and technology course for physical facts learning field]* [Unpublished master dissertation]. Dokuzeylül University.

Patton, M. Q. (2014). *Qualitative research & evaluation methods: Integrating theory and practice*. Sage publications.

P21. (2011). Partnership for 21st century learning. *P21 common core toolkit*.

Pabuçcu Akiş, A., & Demirer, I. (2022). Integrated STEM activity with 3D printing and entrepreneurship applications. *Science Activities*, 1-11.

Pekbay, C. (2017). *Fen teknoloji mühendislik ve matematik etkinliklerinin ortaokul öğrencileri üzerindeki etkileri [Effects of science technology engineering and mathematics activities on middle school students]* [Unpublished doctoral dissertation]. Hacettepe University.

Prema, D., & Dhand, R. (2019). Inclusion and accessibility in STEM education: Navigating the duty to accommodate and disability rights. *Canadian Journal of Disability Studies*, *8*(3), 121-141.

Resmol, K., & Leasa, M. (2022). The effect of learning cycle 5E+ Powtoon on students' motivation: The concept of animal metamorphosis. *JPBI (Jurnal Pendidikan Biologi Indonesia)*, *8*(2), 121-128.

Robinson, A., Dailey, D., Hughes, G., & Cotabish, A. (2014). The effects of a science-focused STEM intervention on gifted elementary students' science knowledge and skills. *Journal of Advanced Academics*, *25*(3), 189-213.

Roldán-Álvarez, D., Martín, E., & Haya, P. A. (2021). Collaborative video-based learning using tablet computers to teach job skills to students with intellectual disabilities. *Education Sciences*, *11*(8), 437.

Salman-Parlakay, E. (2017). *FeTeMM (STEM) uygulamalarının beşinci sınıf öğrencilerinin sorgulayıcı öğrenmelerine, motivasyonlarına ve canlılar dünyasını gezelim ve tanıyalım ünitesindeki akademik* *başarılarına etkisi [Investigation the effect on the academic achievement, interrogating learning skills, motivations of the unit "traveling and knowing the world of life" of fifth grade students of stem practices]* [Unpublished master dissertation]. Mustafa Kemal University.

Scruggs, T. E., & Mastropieri, M. A. (1993). Current approaches to science education: Implications for mainstream instruction of students with disabilities. *Remedial and Special Education*, *14*(1), 15-24.

So, W. W. M., He, Q., Cheng, I. N. Y., Lee, T. T. H., & Li, W. C. (2021). Teachers' professional development with peer coaching to support students with ıntellectual disabilities in STEM Learning. *Educational Technology & Society*, *24*(4), 86-98.

Sowers, J.-A., Powers, L., Schmidt, J., Keller, T. E., Turner, A., Salazar, A., & Swank, P. R. (2017). A Randomized Trial of a Science, Technology, Engineering, and Mathematics Mentoring Program. *Career Development and Transition for Exceptional Individuals*, *40*(4), 196-204.

Tosun, İ. E. (2019). *Özel eğitime gereksinim duyan bireylere yönelik bilgisayar destekli STEM eğitiminin etkileri [Influences of computer-basical stem education on special education students].* [Unpublished master dissertation]. Uludağ University.

Ulukaya Öteleş, U. (2020). A study on the efficiency of using 5E learning model in social studies teaching. *International Online Journal of Educational Sciences*, *12*(4), 111-122.

United Nations (UN). (1948). *Universal declaration of human rights*. United Nations. https://www.un.org/en/about-us/universal-declaration-of-human-rights

United Nations (UN). (1989). *Convention on the rights of the child*. United Nations. https://www.ohchr.org/documents/professionalinterest/crc.pdf

United Nations (UN). (2007). *Convention on the rights of persons with disabilities*. United Nations. https://www.un.org/development/desa/disabilities/convention-on-the-rights-of-persons-with-disabilities.html

White, D. W. (2014). What is STEM education and why is it important? *Florida Association of Teacher Educators Journal*, *1*(14), 1-8.

Willis, A. J. 2017. *Women's choice in college stem majors: impact of ability tilt on women students' educational choice* [Unpublished doctoral dissertation]. Minnesota State University.

Wiriani, N. M. A., & Ardana, I. M. (2022). The Impact of the 5E Learning Cycle Model Based on the STEM Approach on Scientific Attitudes and Science Learning Outcomes. *MIMBAR PGSD Undiksha*, *10*(2), 300-307.

Yamak, H., Bulut, N., & Dündar, S. (2014). The impact of STEM activities on 5th grade students' scientific process skills and their attitudes towards science. *Journal of Gazi Faculty of Education*, *34*(2), 249-265.

Yasak, M. T. (2017). *Tasarım temelli fen eğitiminde, fen, teknoloji, mühendislik ve matematik uygulamaları: Basınç konusu örneği [Applications of science, technology, engineering and mathematics in design based science education: Sample of the theme of pressure]* [Unpublished master dissertation]. Cumhuriyet University.

Yıldırım, B., & Altun, Y. (2015). Investigating the effect of STEM education and engineering applications on science laboratory lectures. *El-Cezerî Journal of Science and Engineering*, *2*(2), 28-40.

Yıldırım, B., & Selvi, M. (2017). An experimental research on effects of STEM applications and mastery learning. *Journal of Theory and Practice in Education*, *13*(2), 183-210.

Yıldız, D., Özkaral, T., & Yavuz, M. (2017). Turkish–technology–art-social studies (Tsta): Integrated learning application. *Journal of Education*, *12*, 1-17.

Yoon, S. Y., Dyehouse, M., Lucietto, A. M., Diefes-Dux, H. A., & Capobianco, B. M. (2014). The effects of integrated science, technology, and engineering education on elementary students' knowledge and identity development. *School Science and Mathematics*, *114*(8), 380-391.

Young, J. L.,Young, J. R., & Ford, D. Y. (2017). Standing in the gaps: Examining the effects of early gifted education on black girl achievement in STEM. *Journal of Advanced Academics, 28*(4), 290 –312.