# THE EFFECTS OF COMPUTER AIDED CONCEPT TEACHING WITH DIRECT INSTRUCTION MODEL ON CONCEPT ACQUISITION OF STUDENTS WITH INTELLECTUAL DISABILITIES

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**THE EFFECTS OF COMPUTER AIDED CONCEPT TEACHING WITH DIRECT INSTRUCTION MODEL ON CONCEPT ACQUISITION OF STUDENTS WITH INTELLECTUAL DISABILITIES**

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## ABSTRACT

### THE EFFECTS OF COMPUTER AIDED CONCEPT TEACHING WITH DIRECT INSTRUCTION MODEL ON CONCEPT ACQUISITION OF STUDENTS WITH INTELLECTUAL DISABILITIES



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The education system is continually developing through the integration of technology into education and the development of new instructional models. Both the instructional models which require technology usage and the presentation of evidence-based models with technology are tested for their effectiveness in the education of students with normal development, as well as for students with intellectual disabilities. Direct Instructional Model is one of the evidence-based instructional methods which is used for the teaching of concepts and skills in special education. The aim of this current study is to develop a technology-based material for concept teaching with the Direct Instruction Model and to examine the contribution of this material on 3-dimensional (3D) cube, cylinder, and cone geometrical shapes acquisition of students with mild intellectual disabilities. Another purpose of the study is to examine the contribution of this material on retention rates of labeling skills of students on newly learned shapes and retention rates of students in the generalization of these newly learned shapes to different contexts in the 3rd, 4th, and 5th weeks after training. Also this study is purposed to check out the social validity of this technology-based material. Multiple probe design across behaviors is used as single-subject research methods in this study. Four students with mild intellectual disabilities, three teachers of these students and six special education experts form the group of participants of the study. Results showed that Shape Finder application have contribution to cube, cylinder and cone shapes acquisition of students with ID and retention of these newly learned shapes in the 3rd, 4th, and 5th weeks after training. The students can generalize the learned shapes to real objects. Also according to interviews with students, teachers and experts, the Shape Finder application is found socially valid.

Keywords: Special Education, Technology Integration in Special Education, Tablet Application, Direct Instruction Model, Technology-Based Material

# ÖZ

## DOĞRUDAN ÖĞRETİM MODELİ İLE GELİŞTİRİLMİŞ BİLGİSAYAR DESTEKLİ KAVRAM ÖĞRETİMİNİN ZİHİNSEL ENGELLİ ÖĞRENCİLERİN KAVRAMLARI EDİNMELERİNE ETKİSİ

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Eğitim sistemi, teknolojinin eğitime entegre edilmesi ve yeni öğretim modellerinin gelişimi ile birlikte günden güne gelişmektedir. Hem teknoloji kullanımını gerektiren yeni öğretim modelleri hem de kanıt temelli modellerin teknoloji ile birlikte sunumu normal gelişim gösteren öğrencilerin eğitiminde olduğu kadar zihinsel engelli öğrencilerin eğitiminde de etkililikleri denenmektedir. Doğrudan Öğretim Yöntemi, özel eğitimde kavram ve becerilerin öğretiminde kullanılan kanıt temelli öğretim yöntemlerinden biridir. Bu araştırmada amaçlanan; Doğrudan Öğretim Modeli ile kavram öğretimini sağlamaya yardımcı bir teknoloji tabanlı materyal geliştirmek ve bu materyalin 3 boyutlu geometrik şekillerden küp, silindir ve koni kavramlarını hafif zihinsel engelli öğrencilerin kazanmalarına katkısını incelemektir. Çalışmanın diğer bir amacı da, bu materyalin eğitimden sonraki 3.,4. ve 5. haftalarda öğrencilerin öğrendikleri bu şekilleri akılda tutmalarına ve farklı durumlara genellemelerine katkısını incelemektir. Ayrıca bu çalışma ile Doğrudan Öğretim Modeli'ne göre geliştirilmiş bu teknoloji tabanlı materyalin sosyal geçerliliğini kontrol etmeyi amaçlamıştır. Bu çalışmada tek denekli desenlerden biri olan davranışlar arası çoklu yoklama deseni kullanılmıştır. Çalışmanın katılımcılarını dört hafif düzeyde zihinsel engelli öğrenci, bu öğrencilerin üç öğretmeni ve altı özel eğitim uzmanı oluşturmaktadır. Çalışmanın sonuçları Şekil Bul uygulamasının öğrencilerin küp, silindir ve koni şekillerini kazanmalarına ve eğitim sonrasındaki 3., 4. ve 5. haftalarda bu şekilleri akılda tutmalarına katkıda bulunduğu ortaya çıkmıştır. Öğrenciler bu kavramları gerçek objelere genelleyebilmiştir. Ayrıca, öğrenci, öğretmen ve uzman görüşmelerine göre Şekil Bul uygulaması sosyal olarak geçerli bulunmuştur.

Anahtar Kelimeler: Özel Eğitim, Özel Eğitime Teknoloji Entegrasyonu, Tablet Uygulaması, Doğrudan Öğretim Modeli, Teknoloji-Tabanlı Materyal

*To My Little Brother Ufuk...*

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| | |
|---|---|
| DIM | Direct Instruction Model |
| ID | Intellectual Disability |
| ASD | Autism Spectrum Disorder |
| MoNE | Ministry of National Education |
| 2D | 2-Dimensional |
| 3D | 3-Dimensional |
| METU | Middle East Technical University |

# CHAPTER 1

# INTRODUCTION

In this chapter, the background and statement of the problem, purpose of the study, research questions, significance of the study and assumptions are presented as an introduction to the study.

## 1.1. Background of the Problem

The interest and demand for education has changed rapidly and teaching has become ever more individualized because of the desire of individuals to take advantage of educational opportunities, and also due to the increased number of students, an imbalance in teacher/student ratios, and the complex content of an increased level of knowledge (Bindak & Çelik, 2006; Yiğit & Akdeniz, 2000). This demand for individualized education has led to the integration of new technologies in education. Computers especially have become an essential tool in education. There is also another reason to use technology in education, and that is students' increasing motivation when computers are used in lessons, and this usage provides opportunities for lifelong learning and improves flexible curricula (Alkan, 1998; Arseven, 1986; Töman, Çimer, & Çimer, 2012).

New findings from scientific studies have provided major contributions to the field of technology and the significant development of technological devices and services. Considering the needs of those with disabilities, special education is one of the fields which most necessitates the use of technology. In special education, technology is generally considered as an assistive technology concept. The concept of assistive technology is defined as the product of any kind of tool or equipment which maintains, improves, or develops the functional capabilities of individuals with disabilities, whether improved for commercial purposes or not (Assistive Technology Act, 1998).

Currently, one of the most commonly used kinds of assistive technology is the computer. Computers are electronic devices which process electronic data, translate these data into a language that can be understood by itself, store these data, present these data when necessary, and store them in its memory for an extended period of time (Yavaş, Eryılmaz, & Alabay, 2001). From the beginning of the use of computers in education, teachers have had an opportunity to develop more visual and audial materials with the aid of computer programs.

Computer-assisted education can be used to render traditional education more effective, more motivating, and thereby more efficient. Learning with computer-assisted education provides more individualized learning, answers students' capabilities and needs, and helps with knowledge retention. With computer-assisted education, learning can be provided not only for the education of students of normal development, but also for the education of students with intellectual disabilities. Students with intellectual disabilities focus more on computer-assisted education and show an increased motivation for learning. In computer-assisted education, refraining from employing unnecessary information or distractions provides students with the necessary focus, and therefore helps make their learning easier. Also, it provides students with the opportunity to discover different solutions freely without fear of inability. Therefore, students with intellectual disabilities benefit more from computer-assisted education (Kiswarday, 1996).

Educating students with intellectual disabilities with the aid of computer programs has grown rapidly in nowadays. In the past two decades, there have been studies published in the literature on finding the effect of computers on children with intellectual disabilities. One of these studies, by Podell, Tournaki-Rein, and Lin (1992), found a significant effect of computer-assisted education on students with moderate intellectual disability while teaching them basic math skills of addition, subtraction, multiplication, and division. However, they also found that students with intellectual disabilities had to repeat the program more than students of normal development.

Another study, by Kiswarday (1996), used a program designed for pre-school students of normal development in the education of students with intellectual disabilities. The results of the study showed that the children taught with computer-based training learned more academic information than the students who were taught based on a normal or traditional education delivery. Another interesting result of this study was that students with severe intellectual disabilities were able to learn using computers more quickly, and that they could use this learned information in other programs and develop the skills faster than expected.

These studies show that information and communication technologies have developed rapidly and that using these technologies in education have become a necessity. According to İsman, Baytekin, Balkan, Horzum, and Kıvıcı (2002), using technology in education provides various opportunities; these are richer learning environments, and more interest and increased motivation with a Student-centered approach. Through such opportunities provided by using computer technologies in education, the quality of education has developed. However, technology can only contribute to education, and only when used with appropriate teaching and learning methods. This condition is especially vital to special education because the education of students with intellectual disabilities requires more specialized conditions, as the name implies.

## 1.2. Statement of the Problem

The main purpose in educating students with intellectual disabilities is to improve their life functions and to provide them with the necessary skills to become independent in their community. The skills necessary for this is composed of basic development skills, numerical information necessary in everyday life, and sub-areas such as the skills required to read and communicate in everyday life (Cavkaytar, 2001). For both living in the moment and for future life, students with intellectual disabilities need self-care skills, communication skills, business skills, and social skills; as well as academic skills (Yıkmış, 1999). Therefore, the teaching of all these skills that are functional in the educational process of students with intellectual disabilities is of significant importance. As with students of normal development, continuing development in daily life and participation in a social life can be achieved by providing education to students with intellectual disabilities. Students can acquire the ability to meet such needs, the ability to communicate with those around them, and the ability to become a person who can be creative and independent in their own right through education. Many educational activities are prepared based on literacy, comprehension, description, and speech (Çolak, 2001).

In the education of students with intellectual disabilities, to gain academic skills like literacy, comprehension, and communication skills, computers can be utilized as assistive tools. Studies have shown that computer-assisted education programs increase the motivation of students with intellectual disabilities, gain their attention for the longer term, and help them to enjoy working in this way (İsman et al., 2002; Lewis & Doorlag, 1999). Also, when traditional education is compared with computer-assisted education, most studies have shown that computer-assisted education programs have a positive effect on the learning of students with intellectual disabilities (Bahr, 1991; Kiswarday, 1996).

Computer-assisted education presents many advantages for students. These are motivating students, being interesting, being able to make learning permanent, developing skills and behaviors as well as knowledge, delaying forgetting in education, making teaching fun, attractive and amusing, having application richness and ensuring the delivery of appropriate training (Doğan, 2003; İsman et al., 2002). Furthermore, teachers and students gain more time because of an accelerated learning process. Computer-generated simulations and models make it easier for students to perceive information, retain it, and thus ensure it is repeatable. (Halis, 2001). In addition, computers allow students to actively enter the learning process and to learn at their own pace (Demirel, Seferoğlu, & Yağcı, 2001).

All such benefits of computer-assisted education are also relevant for students with special needs. It is thought that the use of the computer-assisted education in special education can make it easier for students with special needs to learn and increase their interest in lessons (Doğan & Akdemir, 2015). Under the framework of special education, it can be said that the use of computers for educational purposes in the education of students with Autism Spectrum Disorder (ASD) will be useful for them (Halis, 2001).

When the literature was examined, it could be seen that most studies regarding the use of computer-assisted education in special education were undertaken with students diagnosed with ASD. One of these studies was by Hetzroni and Tannous (2004), who studied children with ASD with regards to delayed speech, echolalia, related and unrelated conversation to a topic, and the ability to initiate communication, and examined the impact of computer-assisted education in the development of these inadequacies. As a result of their study, all participant children showed improvements in the targeted communication skills, and that computer-assisted education was found to be effective.

In other study, video model method and computer-assisted education were applied together in the education of students with ASD. Simpson, Langone, and Ayres (2004) conducted a research that studied the effects of using the video model method and computer-assisted education together on the development of social skills of children with ASD. The aim of the study was to develop the skills of students with ASD in order to be able to share with other people, to comply with their teachers' guidelines and to improve their meeting and greeting skills. As a result of the study, it was seen that all of the participants quickly acquired the targeted social skills.

In addition, a literature review research investigated computer-assisted technology usage in education of students with ASD. The research by Kizir and Yıkmış (2016) analyzed studies aimed at teaching social skills with Computer-Assisted Instruction to children with (ASD). Within the scope of their research, 13 studies published between 2005 and 2015 were examined. It was observed that the researchers created applications to determine the effectiveness of the computer-assisted education in the social skills teaching of students with ASD. Some studies used the same software programs, while others used different types of software. These software used were "Mind Reading," "Collaborative Virtual Learning Environment (CVLE) – 3D Empathy System," "FaceSay™," "Junior Detective Training Program," "MS PowerPoint," "Adobe Photoshop 5.0," "Let's Face It," "The Educational Software," and "Virtual Reality Social Cognition Training." It was found that all of the applications were effective in providing the social skills targeted in the research.

These studies revealed that most research was performed with the participation of students with ASD, and were focused on teaching social skills to these students. Moreover, there have been few studies about the usage of computers on the education of students with intellectual disabilities. Especially lacking are published studies about the use of computers for the acquisition of academic skills in the education of students with intellectual disabilities. However, those few studies showed that computer-assisted education positively affected the learning of students with intellectual disabilities (Bahr, 1991; Kiswarday, 1996; Podell et al., 1992). In an article written by Schmidt, Weinstein, Niemic, and Walberg (1985), they examined studies performed to discover the effectiveness of computer usage in the education of students with intellectual disabilities. A total of 26 articles were investigated, of which, 23 reported computer-assisted education having had an important effect on the education of students with intellectual disabilities, and also students presenting low levels of achievement. It was emphasized by the researchers that computer-assisted education gave the greatest benefit to the learning of students with intellectual disabilities.

Beside the positive effects of the use of computer programs in the education of students with intellectual disabilities, most of these programs were prepared according to the abilities of students of normal development. According to Tanju and Gönen (2006), such programs should be prepared according to the abilities of students with intellectual disabilities. While preparing computer programs for students with intellectual disabilities, more importance and attention should be given to the appropriateness of the developmental level of the students, by using short and clear stimulus, cues to facilitate learning, clear feedback, and emphasizing the most important concepts with supporting visual and audial materials (Tanju & Gönen, 2006).

It is important to prepare software according to the needs of users as individuals. With the use of software prepared according to individual differences, the interests and needs of individuals with ASD when teaching in skill areas such as social, literacy, communication, and academic skills can be more effective (Luiselli, 2014). Computer software prepared for students with ASD can easily be used for different purposes (Bayram, 2006). According to Altınay, Çağıltay, Jemni, and Altınay (2016), it is important to understand the nature of special education needs of individuals in order to help to eliminate the obstacles they face. This understanding can be helpful in order to effectively implement special education methods with the appropriate technology. With this purpose, the current study examines the effectiveness of the proper use of technology with the right instructional model in the acquisition of students with intellectual disabilities.

### 1.3. Purpose of the Study

The main purpose of this study is to develop an application for concept teaching using the Direct Instruction Model for students with Intellectual Disabilities, and to examine the contribution of this developed technology-based material on 3-dimensional (3D) cube, cylinder, and conical geometrical shapes acquisition of students with intellectual disabilities. Another purpose of the study is to examine the contribution of this technology-based material on retention rates of labeling skills of students on newly learned shapes and also retention rate of students in the generalization of these newly learned shapes to different context in the 3rd, 4th, and 5th weeks after training. Also, this study is purposed to check out the social validity of technology-based material which is developed based on Direct Instruction Model for students with intellectual disabilities.

### 1.4. Research Questions

This study posed the following research questions:

- RQ1: Does technology-based material designed according to the Direct Instruction Model contribute to 3-dimensional (3D) cube, cylinder, and conical geometrical shapes acquisition of students with intellectual disabilities?
    - Sub-RQ1.1: Does technology-based material designed according to the Direct Instruction Model contribute to the labeling skill of students with intellectual disabilities on 3-dimensional (3D) cube, cylinder, and conical geometrical shapes?
    - Sub-RQ1.2: Does this material contribute to the generalization of newly learned shapes to different contexts by students with Intellectual Disability (ID)?
    - Sub-RQ1.3: Does this material contribute to the generalization of newly learned shapes to different contexts by using real objects with students with Intellectual Disability (ID)?
- RQ2: What is the retention rate of labeling skills of students on newly learned shapes in the 3rd, 4th, and 5th weeks after training?
- RQ3: What is the retention rate of students in the generalization of newly learned shapes to different context in the 3rd, 4th, and 5th weeks after training?
- RQ4: What are the opinions of students with Intellectual Disability (ID) about the usage of technology-based material designed according to the Direct Instruction Model (DIM)?
- RQ5: What are the opinions of special education teachers and experts about the technology-based material designed according to the Direct Instruction Model (DIM)?

To answer last research question, nine interviews were conducted with three teachers and six experts in special education, and the answers of students with ID were stored in the application in order to examine whether or not they had learned the concepts.

## 1.5. Significance of the Study

In recent years, with the widespread use of technology, computers have become used as tools or goals in education. When computers are used as tools in education, it is observed that student motivation increases, learning becomes concrete, and computers provide diversity and change in the education process (Demirel et al., 2001). Computers can offer individualized learning, executing the delivery of education in an effective and efficient way in order to create a contemporary learning environment.

The education of students with intellectual disabilities is equally as important as the education of students of normal development. In fact, there is a special need for the education of students with intellectual disabilities because their training takes more time and effort than students of normal development. Therefore, in order to decrease the differential between the education of students of normal development and those with intellectual disabilities, materials which can be used as assistive tools are significantly important. When integrated technologies are examined, it can be seen that the latest technology in use is the tablet computer. As it is adapted to the education of students of normal development, it can also be adapted to the education of students with intellectual disabilities. During this technological adaptation period, creating special applications for tablet computers for students with intellectual disabilities can help to decrease the difference between their education and those of normal development. Thus, creating applications for students with intellectual disabilities and examining the applications' effectiveness is of particular importance. Furthermore, it is important to apply the appropriate instructional model which is effective in the education of students with intellectual disabilities in order to increase the effectiveness of the application. Since the 1960's, many studies have shown that the Direct Instruction Model (DIM), which was developed by Engelmann, to be effective in the education of all students, but especially those with intellectual disabilities (National Institute for Direct Instruction, 2015a). The current study aims to combine the Direct Instruction Model and the current mobile technology in order to produce an effective solution for the education of students with intellectual disabilities. It is anticipated that by providing education both at school and at home for students with intellectual disabilities, it can also be possible to make their education more effective and efficient.

## 1.6. Assumptions

Assumptions that are made for this study are as follows:

- Participants will join the study on a voluntary basis;
- Recording of all participants' answers will be undertaken accurately;
- Data of the study will be accurately recorded and analyzed.

# CHAPTER 2

# LITERATURE REVIEW

In this chapter, the related literature pertaining to the research questions listed in Chapter One will be analyzed and synthesized. Firstly, definitions and classifications of intellectual disability are presented. Then, the Direct Instruction Model and Follow Through Project are presented. In addition, the integration of instructional technology into education is examined within an international scope and also domestically in Turkey. Lastly, a summary is given of instructional technology usage within special education, again both at the international and national levels.

## 2.1. Intellectual Disability Definitions and Classifications

Intellectual disability, which is also known as “general learning disability” or “mental retardation” has several definitions, but these definitions share certain similarities with the classification of intellectual disabilities. According to Kar (1992), intellectual disability means having intelligence and mental development problems from early life and throughout the growing period. In order to measure students’ intelligence levels, two tests are applied which are the Standford-Binet and Wechsler Scales. The clinical classification of intellectual disability according to these two tests is shown in Table 1.

Table 1
*Clinical Classification of Intellectual Disability*

| *Intellectual Disability Level* | *Wechsler IQ* | *Standford – Binet IQ* |
|---|---|---|
| Mild | 55 – 69 | 52 – 67 |
| Moderate | 40 – 54 | 36 – 51 |
| Severe | 25 – 39 | 20 – 35 |
| Profound | Under 25 | Under 20 |

(Kar, 1992, p. 16)

Within educational classification, Intelligence Quotient (IQ) levels are also taken as a baseline, and separated into three different levels. Students with an IQ level between 61-85 are termed as "educable," those with an IQ level between 31-60 termed as "trainable," and students with an IQ level below 30 termed as "custodial" (Kar, 1992).

According to Dash (2005), intellectual disability means having lower-level intellectual performance and social adaptability problems. Dash also classified intellectual disability as educable, trainable, and custodial. Students with "educable" intellectual disability have minimum educational problems in school subjects, and therefore require repeated instruction. They also exhibit social adjustment problems. However, students with "trainable" intellectual disability are poor in school subjects and have adaptive skills, so they need education about daily living skills. Furthermore, students with "custodial" intellectual disability need to receive education within a special dedicated class environment as they require more help from other types of intellectual disability (Dash, 2005).

The American Association on Intellectual and Developmental Disabilities (AAIDD) created a definition that most researchers adhere to. The association uses intellectual disability instead of mental retardation or mental disorder; and defines it as having limitations about intellectual functioning and maladaptive behavior that includes everyday social and practical skills, before the age of 18 years old (AAIDD, 2013).

In Turkey, the Ministry of National Education (MoNE) took the AAIDD's "intellectual disability" definition as a baseline and released its own definition. According to the MoNE (2013b), intellectual disability is a disability which originates before age of 18, and is related to significant limitations in intellectual skills and conceptual, social and practical adaptive skills. They classified intellectual disability in four levels and educate according to these levels. These four levels are mild intellectual disability, moderate intellectual disability, severe intellectual disability, and profound intellectual disability.

## 2.2. Behaviorism

Behaviorism is one of the learning theories and it focuses on the behaviors that are observable objectively. It tries to explain how people are behaving and especially how the behavior can be changed or how specific behaviors can be revealed (Harasim, 2012). It was developed in late 19th century and provides an experimental, observable and measurable learning theory by focusing on apparent behaviors that are observable and measurable (Good & Brophy, 1990). By ignoring the possibility of thought processes existing in the mind, the it considers the mind as a "black box" meaning that the response to stimulus can be observed quantitatively (Harasim, 2012). Pavlov, Watson, Thorndike and Skinner have key roles on the development of the behaviorist learning theory. After their studies, Direct Instruction Model of Siegfried Engelmann (Bereiter & Engelmann, 1966a) was emerged especially based on the radical or selectionist behaviorism which was labeled by Skinner (Magliaro, Lockee & Burton, 2005). According to Magliaro, Lockee and Burton (2005) Direct Instruction Model focuses on interaction between teachers and students. Its key components consist of "modeling, reinforcement, feedback, and successive approximations" (Joyce, Weil, & Calhoun, 2000, p. 337). Framing student performance into goals and tasks, subdividing these tasks into smaller tasks, designing training events for mastery learning and organizing learning events into sequences that encourage the transfer and achievement of preconditioned learning before giving more advanced learning are described as instructional design principles of Direct Instruction by Joyce, Weil and Calhoun

(2000). According to Joyce, Weil and Calhoun (2000), actually Direct Instruction is "modeling with reinforced guided performance" (p. 337).

Being active is very important in behavioral-based models such as DI, because according to behaviorist learning theory in order to learn learners must be active. Skinner (1968) stated,

> "*It is important to emphasize that a student does not passively absorb knowledge from the world around him but must play an active role, and also that action is not simply talking. To know is to act effectively, both verbally and nonverbally*." (p. 5)

Accorsing to Harasim (2012), behaviorist learning theory is directed towards instructional design based on very specific and discrete learning stages. Therefore, it can play as a key role in using learning technologies such as teaching machines, programmed instruction and computer-assisted instruction by mechanizing the instructional process. In order to do that, Direct Instruction has a potential as an effective teaching method, especially in technology-driven learning environments (Magliaro, Lockee & Burton, 2005). While computer-aided programs are designed according to teacher centered Direct Instruction approaches, they use technological skills to support feedback, improvement and guided practice which are the key components of the Direct Instruction process to make the learning effective (Magliaro, Lockee & Burton, 2005).

One of the first technology-based programs which was designed according to Direct Instruction was developed by the creators of the DI method. Hofmeister, Engelmann, and Carnine (1986, 1989) developed a reading, math and language videodisc program. In this program, with narration and animation, which were created in short sections, were used to break down complex skills into small steps, to present examples in a wide range and to present other Direct Instruction processes. Five experimental studies were conducted over seven years and results showed that the program was effective for students with low achievement. The study found that continuous observation was necessary for low-achieving students, the range of activities used in each lesson supported to keep the students motivated and interested (Adams & Engelmann, 1996).

This is one of the motivation of the study for choosing the Direct Instruction Model for this study. As Engelmann used Direct Instruction in videodisc program, it can also be implemented in one of today's technologies which is tablet computers. Another motivation for choosing the Direct Instruction is that it eliminates misconceptions that can arise in the learning process because skills are given in small units, ordered in sequence from simple to difficult and skills are given in clear explanations. Therefore, it also allows for accelerated and more efficient learning by providing highly organized and teacher centered approach (Carnine 2000).

### 2.3. Direct Instruction Model

The Direct Instruction Model was produced by Siegfried Engelmann at the beginning of the 1960's in order to bring about a new perspective to instructional models. The first developed Direct Instruction Model's techniques and strategies were tested on his own children. Based on the results, an instructional program was developed with Carl Bereiter between 1964 and 1966 at the Research Institute of Illinois, which examined students with special needs. In 1964, they founded the Bereiter-Engelmann Kindergarten and tested the Direct Instruction Model on disadvantaged children. At the same time, Engelmann improved the central philosophy of Direct Instruction Model with the words, "if a student fails to learn it is not the fault of the student, but rather the instruction" (National Institute for Direct Instruction, 2015a).

After the 1960's, Engelmann conducted many studies about Direct Instruction Model's techniques and programs in order to understand how students of different backgrounds and varying skill levels learned (Bereiter, & Engelmann, 1966a; Bereiter, & Engelmann, 1966b; Bereiter, & Engelmann, 1966c; Bereiter, & Engelmann, 1966d). His studies were mostly designed to understand how to teach students as efficiently and effectively as possible, and how appropriate instruction differs for students of different backgrounds and skills. Results showed that students gaining of information and their development of skills is dependent on their teachers' appropriate instruction, and that they also require adjustment based on students' skill levels (National Institute for Direct Instruction, 2015b).

The Direct Instruction Model, based on Engelmann's studies, was improved by Siegfried Engelmann, Wes Becker, and Douglas Carnine, then a further publication was issued in 1991 by Engelmann and Carnine (Engelmann, Becker, Carnine & Gersten, 1988; Engelmann & Carnine, 1991; Tuncer & Altunay, 2012).

Many studies have been conducted over more than 40 years on the Direct Instruction Model. As a result of studies conducted with different populations and in different environments, the results demonstrated the model to be significantly useful. These studies have also been published in a number of books such as Conceptual Learning (Engelmann, 1969), Theory of Instruction: Principles and Applications (Engelmann & Carnine, 1982), Inferred Functions of Performance and Learning (Engelmann & Steely, 2003), and Could John Stuart Mill Have Saved Our Schools? (Engelmann & Carnine, 2011). These publications revealed two main principles about the Direct Instruction Model, which are;

1- "*All children can learn when instruction is systematic, explicit, and efficient; and*
2- *Poor achievement does not result from poor students, but from poor teaching"* (National Institute for Direct Instruction, 2015b).

The Direct Instruction Model is designed to increase the effectiveness and efficiency of learning to a maximum. In this model, it aims that while teaching, by determining the students' skill levels, teaching can be maintained as appropriate to this level. Considering this purpose, it is suggested to use the Direct Instruction Model mostly on the education of students with intellectual disabilities. Therefore, with teacher-centered education appropriate to the skill levels of students with intellectual disabilities, students can achieve the same skill levels with students of normal development.

The Direct Instruction Model aims to make learning more efficient and effective in the minimum time for all students. With this aim and in order to achieve learning, three main components have emerged; program design, organization of instruction, and

Student-teacher interaction (Tuncer & Altunay, 2012; Watkins & Slocum, 2003). Program design components include the following five main elements:

1- Content analysis
2- Clear communication
3- Instructional formats
4- Sequencing of skills
5- Track organization

Program design is intended to be more effective with appropriate analysis and determination of these five main elements. Like program design, the organization of instruction component also includes four main elements (Tuncer & Altunay, 2012; Watkins & Slocum, 2003), which are:

1- Instructional grouping
2- Instructional time
3- Scripted presentation
4- Continuous assessment

Through these four elements, which belong to the organization of instruction component, instruction is aimed to be more effective and efficient in an organized manner, with appropriate groupings and continuous assessment. The final component of the Direct Instruction Model, student-teacher interaction, includes seven main elements (Tuncer & Altunay, 2012; Watkins & Slocum, 2003), which are;

1- Active student participation
2- Group unison responding
3- Signals
4- Pacing
5- Teaching to mastery
6- Correction procedures
7- Motivation

The Direct Instruction Model is a teacher-centered model and the teacher's role is clearly defined. With the elements presented in the Student-teacher interaction component, teachers can strive to make lessons more effective and thereby motivate their students easily (Tuncer & Altunay, 2012; Watkins & Slocum, 2003).

In addition to these main components, the Direct Instruction Model separates forms of information into four main topics. These topics are verbal associations, concepts, rule relations, and cognitive strategies (Engelmann & Carnine, 1991; Tuncer & Altunay, 2012). These forms of knowledge are defined briefly as follows:

**Verbal Associations:** It is defined as the combination of stimulus and a special kind of reaction. There are three different types of verbal association form, which are simple facts like "1 kilometer is 1,000 meters," verbal chains such as "count off by twos up to twenty" and discriminations to distinguish similar stimuli such as "p" and "q."

**Concepts:** It is defined as a general idea derived or inferred from a specific object, event, action or condition like blue, table, below, or to cry.

**Rule Relations:** It is a situation that reports the relationship between at least two cases like discrimination and concepts. For example; "Water freezes at zero degrees," and "Heated air rises" are rule relations.

**Cognitive Strategies:** It is defined as a sequence of steps for analyzing a simple case, verbal chain, concept, or rule. Solving a mathematical problem, answering questions about a paragraph are both considered cognitive strategies.

The Direct Instruction Model aims to make learning more effective and efficient by ordering the information from simple to complex in the frame of these forms of information. In order to examine the effectiveness and efficiency of the Direct Instruction Model, studies have been conducted for many years (Bereiter & Engelmann, 1966c; Engelmann, Becker, Carnine & Gersten, 1988; Engelmann & Carnine, 1991; Shippen, Houchins, Steventon & Sartor, 2005; Özokcu, Akçamete & Özyürek, 2017) The longest and most comprehensive of these study projects was the Follow Through Project.

## 2.4. Follow Through Project

The Follow Through Project was the most comprehensive study conducted to test the Direct Instruction Model. This work is the most comprehensive research work on education in history (National Institute for Direct Instruction, 2015c). Under the sponsorship of the US federal government, the research was launched in 1968 and continued through until 1976. The aim of the project was to determine the best way of teaching at-risk students from kindergarten through the first three grades of elementary school. With this aim, approximately 100,000 students from 170 different residential areas participated in this research. With demographic diversity in both rural and urban areas, blacks, whites, Mexicans, Spaniards, and Native Americans participated in the study. In each region where the study was conducted, there were control groups and experimental groups (National Institute for Direct Instruction, 2015c; Tuncer & Altunay, 2012).

In Tuncer and Altunay's (2012) research, nine different instructional models were focused upon and these models were grouped under three main categories. These main categories and instructional models are:

1- Models which focus on basic academic skills' instruction
    a. Direct Instruction Model
    b. Behavior Analysis
    c. Language Development "Bilingual Education" Approach
2- Models emphasis on cognitive growth
    a. Tucson Early Education Model
    b. Cognitively Oriented Curriculum
    c. Parent Education
3- Models focus on the affective domain
    a. Bank Street
    b. Open Education
    c. Responsive Education (Tuncer & Altunay, 2012, pp. 19-23).

The Follow Through project was huge in terms of both training models and data analysis. In order to measure the real effectiveness of instructional models in this research, which continued over many years, students' performances, and who participated in the research was measured repeatedly at the end of each year from both the beginning of the program and until the end of the 3rd grade. In order to measure students' achievement of basic academic skills, cognitive domain skills and affective domain skills, more than one scale instrument was applied:

- Metropolitan Achievement Test
- Wide Range Achievement Test
- Raven's Colored Progressive Matrices
- Intellectual Achievement Responsibility Scale

Data obtained in the application of these scales were compared between the control and experimental groups, as illustrated in Figure 1.

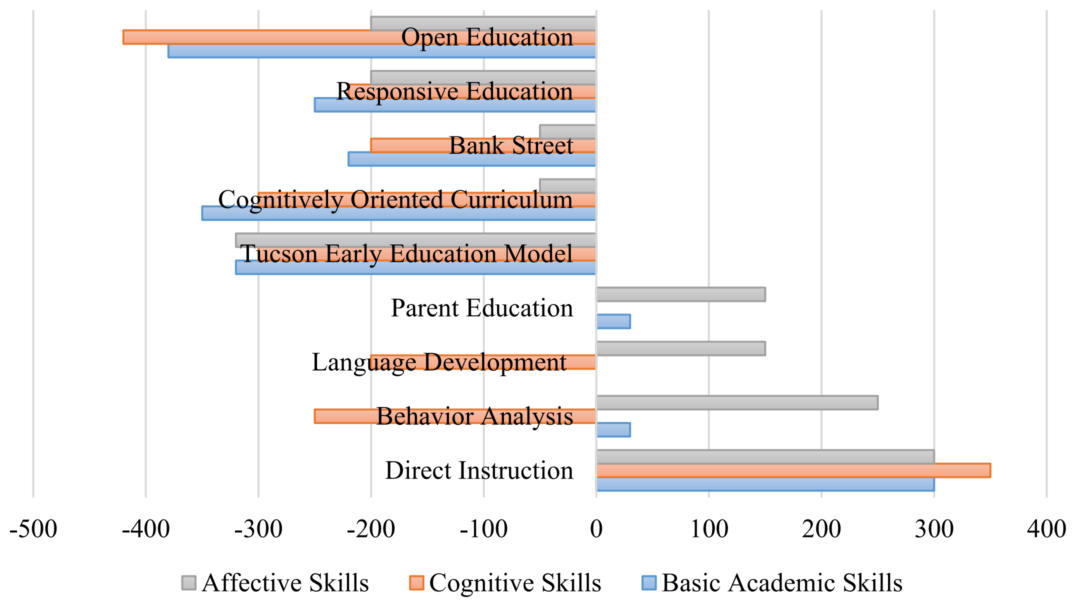


Figure 1: Comparison of Experimental and Control Group Instructional Models (Tuncer & Altunay, 2012, p. 24)

Figure 1 shows the comparison between the results of students in control groups those educated with the Direct Instruction Model, basic skills, cognitive and affective skills showed statistically more meaningful and positive results. However, at the end of the teaching, students educated with other instructional models resulted in lower performance than that of the control group's students (Tuncer & Altunay, 2012). As a result, the performance of students educated with the Direct Instruction Model were higher than those educated with other instructional models.

### 2.5. Studies about Effectiveness of the Direct Instruction Model

There have been many projects undertaken on the Direct Instruction Model apart from the Follow Through Project (Adams & Engelmann, 1996; American Institutes for Research, 1999; Shippen et al., 2005; Hattie, 2009; Cadette, Wilson, Brady, Dukes & Bennett, 2016; Özokcu et al., 2017; Zhang, 2017). One such project, by Adams and Engelmann (1996), conducted a meta-analysis research to evaluate the effectiveness of the Direct Instruction Model (DIM). With this aim, they examined more than 350 publications which had convenient features like pre-test scores, comparison groups, Direct Instruction Model curriculum, as a meta-analysis of 34 research papers. The results showed that 32 of the 34 research papers' effect size scores were positive, with a mean effect size per individual variable of .97 and a mean effect size per study of .87 (Adams & Engelmann, 1996).

The Direct Instruction Model also used in a school reform research (American Institutes for Research, 1999) sponsored by the American Association of School Administrators (AASA), American Federation of Teachers (AFT), National Association of Elementary School Principals (NAESP), the National Association of Secondary School Principals (NASSP), and the National Education Association (NEA). In this research, 24 instructional models used in the reorganization of the school curriculum and their effects on school performance were investigated. This research was the first comprehensive school reform (CSR) research where the instructional models were specifically examined and evaluated systematically. The Direct Instruction Model was one of two models which received the highest vote as a model that positively affected student achievement in primary and secondary education (American Institutes for Research, 1999).

Like the Follow Through Project, Borman, Hewes, Overman, and Brown (2003) also aimed to observe the effectiveness of the DIM and other instructional models. They studied the effectiveness of 29 instructional models within a school improvement program. Their results revealed that the Direct Instruction Model had the highest average effect and appeared in most of the examined research studies.

Another study about the effectiveness of instructional models was undertaken by Hattie (2009), who looked to uncover the most effective model by synthesizing previous research on factors affecting student achievement. From a total of 304 studies conducted with approximately 42 thousand students, it emerged that Direct Instruction Model was statistically more effective than other instructional models. Also, the synthesized studies not only included students of normal development, but also students with special needs and those with lower-level performance (Adams & Engelmann, 1996; Hattie, 2009). These research studies showed that the Direct Instruction Model had a positive effect on the students.

Apart from these studies, there have been many studies about the effectiveness of the Direct Instruction Model. One of them was conducted by Shippen, Houchins, Steventon, and Sartor (2005) who investigated the particular effects of two Direct Instruction reading programs. One program was created with overt decoding strategies, whilst the other employed more covert decoding strategies. In total, 55 students who were 7th graders in an urban middle school and struggled with their reading achievement participated in the study. The results revealed that both the overt and covert Direct Instruction program had a significant effect on the students' reading.

Another study was conducted in order to examine the effectiveness of Direct Instruction in teaching students with ASD to answer "Wh-" questions (Cadette et al., 2016). In this study, especially three "wh-" questions of "who," "where," and "what" were attempted to be taught through the Direct Instruction Model. Three secondary students with ASD participated in this study. The results of which indicated that the

Direct Instruction Model was effective in teaching the specified questions to each of the participants.

The Direct Instruction Model is not only used in the teaching of grammar or reading skills, but also in the teaching of geometry. Zhang (2017) conducted a study to examine the effectiveness of visual working memory training and Direct Instruction on geometric problem solving. Participants of Zhang's study consisted of four students with reported difficulties in geometry. The results showed that the Direct Instruction Model had an effect on the geometry problem-solving skills of the students.

Lastly, Özokcu et al.(2017) conducted a study about the effectiveness of the Direct Instruction Model on the acquisition of social skills of students with intellectual disability. The social skills specified for the study were apologizing, asking for help, and finishing a task on time. This study was conducted in a regular classroom setting, with three participant students with intellectual disability. The study also examined the generalization of these target skills, with results showing that each of the participants gained ability in the target skills and also generalized these skills. In other words, the Direct Instruction Model was effective in teaching target skills to students with intellectual disability.

Results of the studies summarized here reveal important clues about the effectiveness of DIM. Each showed DIM to be an effective and efficient model in the education of both students of normal development and students with intellectual disabilities. It is postulated that the integration of DIM into technology-based material would provide more effective and efficient teaching material for students with intellectual disabilities.

## 2.6. Integration of Instructional Technology into Education

Instructional Technology has a long history and many definitions. These definitions are similar based on general features and definitions made in the past are still accepted today. Instructional Technology was defined by the Commission on Instructional Technology (1970) as:

> *...the media born of the communications revolution which can be used for instructional purposes alongside the teacher, textbook, and blackboard....a systematic way of designing, implementing and evaluating the total process of learning and teaching in terms of specific objectives, based on research in human learning and communication and employing a combination of human and non-human resources to bring about more effective instruction.* (p. 19)

In line with the emerging needs in education, the integration of instructional technology in education has become of significant importance. Many institutions and organizations use Instructional Technology to train both students and employees in a more effective and efficient modus. Applying Instructional Technology and materials within education provides many benefits in addition to the enrichment of the educational environment. Some of these benefits are listed as:

- Increases interest and encourages learning;
- Encourages students to examine the subject;
- Provides connection to previously learned information with new information;
- Helps to relate a subject to students' experiments;
- Enables students to reach information and evaluate this information;
- Helps students to depict the world as they see it;
- Provides focus on information for ease of understanding;
- Increases self-education (Hackbarth, 1996).

According to Tiene and Luft (2001), working in a technology-rich environment designed in an appropriate way can provide many positive results. These results include improved social interaction models, changes in teaching methods, more effective teaching, increased student and teacher motivation, and the development of student learning. However, in order to realize these results, the correct technology must be defined and integrated within the educational process in an appropriate way. Just forcing the use of instructional technology by bringing computers and computer software into lessons is both inadequate and ineffective. The subject is much more than just the existence of the technology. The real subject is when and under what conditions the technology is used. Teachers should integrate technology using the necessary strategies and pedagogical information in the same way as for other instructional models (Viadero, 1997, p. 16).

The integration of instructional technologies in a course needs to be carried out not only with technology, but also with the appropriate content, strategies, and an effective teaching plan. Technology can be thought of as a tool which can transform content in more effective way. The inclusion of technology in a course should carried out after answering questions like how and why technology is to be used, instead of what technology will be used or how many technologies there are.

## 2.7. Integration of Instructional Technology into Education in Turkey

In Turkey, Instructional Technology began to be integrated into schools in 1930 with maps, laboratory instruments and filmstrip projectors. However, until the 1940's, written instructional materials were used mostly. Between the 1950's and the 1970's, audio cassettes and projectors were then brought into use in schools. Distance education was first available to students in Turkey in 1974. In the 1970's, many newer instructional materials were provided to schools and introduced to teachers. Furthermore, some universities began to give instructional technology education as a graduate program (Hızal, 1991).

Many different technologies such as filmstrip projectors, audio reel and cassette tapes and overhead projectors were introduced into education in Turkey during the integration of instructional technology. Now, computers, tablet computers, and interactive whiteboards are the means of delivering instructional technology in education. Therefore, the development of technology and the emergence of new technological devices has raised curiosity about how these technologies will positively contribute to education, with researchers and educationalists considering how these products can be most effectively used in education.

When history is considered, computers were first used in education in Turkey in 1985. The MoNE started a pilot study by distributing 1,100 computers to 121 secondary schools with ratio of one computer to every 10 students. Between 1985 and 1986, a total of 2,400 computers were distributed to secondary and vocational schools. In-service training was also given to 225 teachers and computer use was included in the curriculum. At the outset, priority was afforded to the hardware rather than the software, and then programming languages were taught at the beginner level. Computers were provided to many schools and instructional content were developed in various subject areas. Furthermore, at the end of the study, instead of educating students only on the use of computers, it was noticed that computers should also be used as part of the instructional materials (Akkoyunlu & Orhan, 2001).

Recently, a large project related to instructional technology in Turkish schools has been implemented. The project is called, Increasing Opportunities Improving Technology Movement, but is more commonly known by its Turkish acronym, "The F@TIH Project." The aim of the project was to make lessons more effective and efficient by using information technology in the teaching-learning process in a way that will appeal to more senses. Accordingly, LCD Panel Interactive Whiteboards and Internet infrastructure were provided to 570,000 classrooms in all schools at the primary and secondary level. Also, it was planned to provide tablet computers to all teacher and student. Furthermore, to ensure teachers' effective and efficient use of technological tools, in-service training would be given to teachers (Ministry of National Education, 2012).

With this project, the use of instructional technology in education has become quite common across Turkey. Even if it takes a long time to complete the project roll-out, in the process an undeniable and important contribution to education will have been made. Differences between technology usage skills of teachers and student will be reduced and these two education users will have become more effective and efficient as a whole, in addition to their personal development.

## 2.8. Instructional Technology Usage in Special Education

In the literature, various instructional technology usage examples in special education relate to problems like academic achievement, reading skills, social-emotional skills, and communication skills that students with intellectual disabilities (ID) often face. The results of these studies infer that using computers or other technological devices in education for students with ID may positively affect the development of academic and social skills of these students (Wehmeyer, 1998).

One study on the academic achievement of students with ID was by Sharma and Swadia (2016). They examined the effectiveness of computer-assisted instruction on the academic achievement of 28 students with ID who participated in the study. In order to measure their academic achievement, an educational assessment checklist was employed. The researchers compared regular classroom teaching instruction with computer-assisted instruction, and the results showed the computer-assisted instruction to be more effective than that of the regular classroom teaching instructions on the academic skills acquisition of students with ID. Sugasawara and Yamamoto (2007) also used computer-based instruction in their study. They examined the effectiveness of a computer-based program on the instruction of reading and construction of words for students with ID. The study's results showed that the reading skills of students with ID was positively affected by using the computer-based instruction.

According to the literature, instructional technologies have also been used to improve the daily life skills of students with ID. Going shopping is a daily life skill faced by almost all individuals. Mechling, Gast, and Langone (2002) looked at the effectiveness of a computer-based video program on reading shopping aisle signs and locating goods in an unknown store. Participants of the study were students with moderate ID. Results of this study showed that the students improved their reading and locating skills. In addition, computer-based multimedia instruction was used in order to teach students with ID how to use a debit card in an automatic teller machine (ATM). Results of the study revealed that this instructional method was successful in teaching the skill to students with ID (Mechling, Gast, & Barthold, 2003). Safety skills can also be counted as a daily life skill. In order to teach skills like school parking lot safety to students with ID, computer-based instruction was used in a study by Shelton (2016). In the study, multiple video examples were used as computer-assisted instruction, and the results showed that using multiple video examples was effective in teaching and improving the safety skills of students with ID.

For students with ID, various computer programs have been developed, with most related to the development of social skills of students with ID. Lozano, Ballesta, and Murcia (2011) conducted a study that examined the effectiveness of an educational computer program, which was developed for children in primary and secondary education, to help teach them social and emotional skills. Participants of the study were nine children aged 8-18 years with difficulties in expressing their emotions. The result of the study showed that the developed program positively affected these autistic children, and that the positive developments were also noticed by the students' families and teachers.

Another program was developed by Escobedo et al. (2012); an assistant tool named Mobil Social Compass (MOSOCO). It was used to develop the social skills of 12 children with ASD. In the study, the social skills emphasized were making eye contact, cohering with peers, and conversing about themselves. The results revealed that the learning and implementation of social skills were facilitated by the developed tool, MOSOCO, and that the qualitative and quantitative social interaction of the participant students were strengthened by this tool.

In another study, the effectiveness of touch-screen tablet applications in the development of the social skills of children with ASD was examined. Three children aged 9-13 years participated in a study to improve the creativity, fine motor, sequencing, sharing, and cooperative skills of children. The project designed and developed tablet computer applications. The findings of the study showed that the developed tablet applications were effective in aiding the development of specified social skills of the participants (Hourcade, Bullock-Rest, & Hansen, 2012).

Another study conducted with children with ASD was by Tang, Jheng, Chien, Lin, and Chen (2013), in which a system named "iCAN" was designed and developed. Arrangement of a Picture Exchange based on Communication System (PECS) was at the core of the iCAN system, which was also used in the communication of children with ASD. Participants of the study were 11 children aged 5-16 years with diagnosed ASD. The results of the study showed that the iCAN system was useful to the children with ASD.

To summarize, the literature provides many examples of studies conducted in the special education field on the usage of instructional technology, with most studies related to the improvement of academic, social, and daily life skills of students with ID. It is clear that technology usage in special education has a positive effect on students with ID. Therefore, it is predictable that the use of technology will become more widespread in special education in the coming years.

## 2.9. Instructional Technology Usage in Special Education in Turkey

In addition to the standard schooling, instructional technologies have an important role in special education. Special education institutions conduct their activities under the supervision and control of the MoNE in Turkey. During the 2012-2013 academic year, in the formal training of special education, there were a total of 1,261 special schools teaching 220,649 students with a total of 10,344 teachers (Ministry of National Education, 2013a).

Instructional Technologies can be useful in the education of students with intellectual disabilities, just as for students of normal development. When the integration of technology in a course is prepared with the appropriate content, pedagogic information, and design, the course can be useful for all environments and students.

One of the current instructional technologies is the computer, and it provides many educational advantages for students with intellectual disabilities. Many studies have revealed that using instructional technology in special education positively impacts on the academic achievement of students, and on their motivation, classroom behavior, and their self-esteem. Computers can be utilized as assistive tools in teaching subjects to students who have problems in areas like writing, spelling, and reading, because of its important features such as learning through games, and the ease of providing instant feedback (Tanju, 2004).

According to Tanju (2004), while using computer programs in the education of students with intellectual disabilities, some features must, however, be considered:

- To intensify student attention, important information should be emphasized with features such as audio and visuals;
- Information to be taught in program content should be presented in a clear and understandable way, and should be appropriate to the students' skill level;
- To ease learning, there should be cues and aids;
- There should be feedback for each answer (e.g., rewards for correct answers, support and the chance to try again for incorrect answers);
- Programs should follow a path from simple to complex (Tanju, 2004).

In line with this information, to evaluate the effectiveness of computer usage in the education of students with intellectual disabilities, some studies have been performed in Turkey. One such study was by Aşçıoğlu (1997). The aim of the study was to evaluate the effectiveness of a computer program developed for students with intellectual disabilities. According to the results of the study, students gained more self-confidence when they saw their own successes, students who had a computer at home were more successful in the usage of the computer, and lastly, that students who were taught through computer-assisted education showed a higher level of performance than students who did not learn through computer-assisted education (Aşçıoğlu, 1997).

Another study, by Tanju (2004), researched the effects of computer-aided education on the acquisition of shapes, color, and number concepts by students with intellectual disability. The participants were 27 mentally handicapped children with a developmental level of children aged 4-5 years, from four different private special education institutions in Ankara, Turkey. According to the statistical evaluation results for the concept of shape, color, and number, there were significant differences seen between the cognitive processes of the experimental and control groups in favor of the experimental group who were subjected to computer-aided education (Tanju, 2004).

Additionally, e-learning can also be used in the education of students with intellectual disabilities. Aruk (2008) conducted a project aimed at making education easier, cheaper, delivered in a shorter time, to make education more enjoyable and effective by applying e-learning for mentally handicapped students. Also, another purpose of the study was to make improve mentally handicapped children individually through the application of learning technologies. The results revealed that e-learning created advantages for the mentally handicapped students. After using e-learning, acquiring the children's attention became easier, their learning and detection speed increased, they could make illustrations of the concepts in their minds more easily, their class attendance increased, the learned concepts became more permanent, lectures became more enjoyable, and the pace of instruction was able to be increased.

For special education there are interactive training CDs available that are designed to teach concepts to students with intellectual disabilities. In a study by Yılmaz (2008), these CDs were examined for the appropriateness of design principles and concept-teaching principles. In the research, two randomly selected interactive training CDs were used to explain concepts in general without adhering to deductive educational methods as it is not considered appropriate for concept-teaching principles in the education of students with intellectual disabilities. The two interactive training CDs were found to be weak examples of instructional equipment for students with intellectual disabilities (Yılmaz, 2008).

In order to develop the writing skills of students with ID, Microsoft Word program can be used. Armutçu (2008) conducted a research in order to find the effectiveness of simultaneous prompting on teaching writing skills by using Microsoft Word with students who have intellectual disabilities, and also for the generalization and maintenance effects of simultaneous prompting. The results showed that education with simultaneous prompting was effective for the teaching of writing skills by using

Microsoft Word program with three students selected with intellectual disabilities. The results also showed that this education influenced generalization and maintenance of the writing skills.

Instructional technologies can also be used in teaching mathematics skills to students with intellectual disabilities. In a study by Reis et al. (2010), IT-based exercises were used to teach mathematics to students with cerebral palsy and intellectual disabilities. The results of the study revealed that students became happier and more interested in their work, wanted to continue their work, and also more easily learned the concept through learning with multimedia exercises (Reis et al., 2010).

Daily living skills are an important part of life. Therefore, it is of vital importance to teach these skills to students with intellectual disabilities. Shopping can be seen as one of the daily living skills. In a study by Cakmak and Cakmak (2015), independent shopping skill was taught to people with ID using an iPad animation developed for the study. According to the results of the study, this animation practice was effective in teaching shopping skills to people with ID using an iPad (Cakmak & Cakmak, 2015). Similarly, Yeni (2015) conducted a study examining the effectiveness of educational tablet computer applications to teach daily living skills to students with intellectual disabilities. In the study, the researcher examined this learned skill maintained over one, three, and four weeks following the application, and whether or not the participants could generalize the skill to different tools. Seven individuals with ID and five special education teachers participated in the study with a tablet application created about the daily living skill of carpet sweeping. The results showed that the tablet application about this daily life skill was an effective tool for teaching to individuals with ID. Also, it was seen as effective in the participants' retention of the learned skill and in their generalization of the skill to other tools.

When these studies were examined, it can be seen that while creating a system or an application for students with ASD or intellectual disabilities, it is important to understand the children's conditions and needs. According to Abidoğlu, Ertuğruloğlu, and Büyükeğilmez (2017), in order to benefit from computer-assisted education for children and individuals with ASD, software should be designed according to different educational development fields and for appropriate stages. In addition, the academic and social-emotional skills should be supported, inadequacies should be extensively addressed, and the language and communication skills of the users encouraged by the application or system in development. Moreover, the age, interests, and skills level of the children must also be considered while designing and developing software (Abidoğlu et al., 2017).

In conclusion, in order to use technology in the education of students with intellectual disabilities effectively and efficiently, the studies in the literature revealed that technology to be a useful material source for students with intellectual disabilities. However, there is also a need to pay attention to instructional models, preparing content that is appropriate to the students' skill and cognitive levels, and ensuring pedagogical information is sufficiently considered while integrating technology. In special education in Turkey, due to a general lack of materials covering a variety of topics related to children with disabilities, there is still a considerable gap in terms of finding suitable learning materials (Doğan, 2015). In light of this, information gained from conducting further studies with regards to creating instructional technology-based materials will aid the development of instructional technology assistive-learning tools, not only for the education of students of normal development, but also for students with intellectual disabilities.

### 2.10. Summary

A review of the literature provides details of the importance and advantages of technology usage for educating students with disabilities. However, there is still a gap for technology-based learning tools designed according to the most appropriate teaching methods for disabled students. The number of studies about technology usage in special education was found to be limited both at the national and international level. Moreover, the existing literature was generally found to be about the effectiveness of technologies in special education, although they were not focused on how to integrate teaching methods with technological devices, or how to use technology with appropriate teaching methods in the field of special education. Therefore, there is a need for research on the issue of how to integrate appropriate teaching methods into technology-based teaching materials in the field of special education. The Shape Finder application, which is a development of the current study, is an example of using appropriate teaching methods in technology-based teaching material in the scope of special education. Thus, it is expected that this application will be a leading example for future studies in addition to addressing the current gap in the literature.

In order to teach a concept to students with intellectual disabilities, educators should also offer variety in the types of materials used to teach concepts like the color red, a book, or a square. Teachers must prepare different types of these concepts in order to show similar kinds of the concept according to what the students may see in daily life. This creates an additional workload for teachers. However, developing technology-based teaching materials based on appropriate teaching methods like the Shape Finder application can help with the teachers' workload. Also, this type of application can provide an opportunity for students to learn these types of concepts within their home environment alongside their families. The current study aims to provide teachers and families with a technology-based application developed based on an appropriate teaching method for students with intellectual disabilities.

Finally, the researcher attempted to locate Turkish language tablet applications which could be helpful in the education of her younger brother who has intellectual disabilities. The researcher found some applications about matching shapes, colors, or puzzles, but was unable to find any application which could help in the teaching of concepts. Therefore, in search for a concept-teaching application, the basis for this dissertation study was borne. The study is therefore of personal significance to the researcher in seeking to develop a concept-teaching application by using the Direct Instruction Model as the appropriate teaching method for students with intellectual disabilities. Furthermore, there is a need in the literature and also in real life for effective applications in special education. By developing an application and conducting research about this application, the researcher aims to address this gap in the literature.

# CHAPTER 3

# METHODOLOGY

In this chapter, the research methodology of the study is explained under subsections entitled; Purpose of the Study and Research Questions, Design of the Study, Researcher's Role, Participants of the Study, Application Design Process, Data Collection Procedures and Instruments, Data Analysis, and Trustworthiness. Also subsections titled; Limitations, and Timetable of the Study are also presented in this chapter.

## 3.1. Purpose of the Study and Research Questions

The purpose of the study is to develop a technology-based material for the concept teaching of 3-dimensional cube, cylinder, and cone geometrical shapes based on the Direct Instruction Model using tablet computers, and to examine the contribution of this developed technology-based material on 3-dimensional (3D) cube, cylinder, and conical geometrical shapes acquisition of students with intellectual disabilities, to examine the contribution of this technology-based material on retention rates of labeling skills of students on newly learned shapes and also retention rate of students in the generalization of these newly learned shapes to different context in the 3rd, 4th, and 5th weeks after training. Also, this study is purposed to check out the social validity of technology-based material which is developed based on Direct Instruction Model for students with intellectual disabilities.

- RQ1: Does technology-based material designed according to the Direct Instruction Model contribute to 3-dimensional (3D) cube, cylinder, and conical geometrical shapes acquisition of students with intellectual disabilities?
    - Sub-RQ1.1: Does technology-based material designed according to the Direct Instruction Model contribute to the labeling skill of students with intellectual disabilities on 3-dimensional (3D) cube, cylinder, and conical geometrical shapes?
    - Sub-RQ1.2: Does this material contribute to the generalization of newly learned shapes to different contexts by students with Intellectual Disability (ID)?
    - Sub-RQ1.3: Does this material contribute to the generalization of newly learned shapes to different contexts by using real objects with students with Intellectual Disability (ID)?
- RQ2: What is the retention rate of labeling skills of students on newly learned shapes in the 3rd, 4th, and 5th weeks after training?
- RQ3: What is the retention rate of students in generalization of newly learned shapes to different contexts in the 3rd, 4th, and 5th weeks after training?
- RQ4: What are the opinions of students with Intellectual Disability (ID) about the usage of technology-based material designed according to the Direct Instruction Model (DIM)?
- RQ5: What are the opinions of special education teachers and experts about the technology-based material designed according to the Direct Instruction Model (DIM)?

### 3.2. Design of the Study

In this research, multiple probe designs across behaviors (Kucera & Axelrod, 1995; Tawney, Skouge, & Gast, 1984), which is one of the single-subject research methods has been employed. Single-subject research approach focuses on individual performance and allows evaluating independently the value of a study or a series of studies (Gast & Ledford, 2010).

In this approach there are six primary design types; these are the pre-experimental (or AB), withdrawal (ABA/ABAB), multiple-baseline/multiple-probe, changing-criterion, multiple-treatment, and the alternating and adapted alternating treatment designs (Byiers, Reichle, & Symons, 2012). In order to evaluate the effectiveness of the independent variable based on its impact on the dependent measure, against several functionally similar behaviors stated by several different participants, the multiple probe design was selected. So as to evaluate each participant individually, across behaviors design, which is one of the multiple probe types, was selected for this study (Gast & Ledford, 2010). In this design, the effectiveness of a teaching concept or behavior modification program can be assessed by applying it to more than one behavior that shares the same difficulty level. With this design, the effectiveness of the application can be tested for the same subject with at least three skills, concepts, or behaviors (Kırcaali-İftar, & Tekin, 1997).

According to Gast and Ledford (2010), in multiple probe and multiple baseline designs, in order to provide internal validity, firstly pre-intervention data should be collected synchronically across at least three or more tiers which can be across behaviors, conditions, or participants. This situation can be explained as follows:

> *Ideally, when baseline data in all tiers show acceptable stability in level and trend direction, the independent variable is introduced to the first tier. However, if stability is achieved in only one tier you may introduce the independent variable to that tier while maintaining baseline conditions in other tiers. Upon introduction of the independent variable to the first tier there should be an immediate, and ideally abrupt, change in the dependent variable in a therapeutic direction in the first tier, while data in other tiers remain stable and unchanged. When criterion-level performance is attained in the first tier and stability is achieved in the second tier, the independent variable is introduced to the second tier, while maintaining baseline procedures in the third tier. Again, the same immediate behavior change should be observed, while uninterrupted*

*baseline data series remain unchanged. This process is repeated in the third tier, and so on, until the independent variable has been introduced to each tier. An immediate change in level, regardless of the magnitude of the change, as well as a change in a therapeutic trend direction should be observed upon introduction of the independent variable for each tier, not before.* (Gast & Ledford, 2010, p. 278)

In order to identify the effectiveness of technology-based material designed for tablet computers based on DIM in the concept teaching of students with ID, multiple probed design across behaviors tier was selected to be applied in this study. In this instance, the three tiers corresponded to the three behaviors of labeling and distinguishing cube, cylinder, and cone shapes.

The dependent variable was the percentage of correct responses during probe, baseline, training evaluation, generalizability, and sustainability conditions for the cube, cylinder, and cone shapes. The independent variable was the concept-teaching application named “Shape Finder” that was used to teach the three shapes (cube, cylinder, and cone) within the context of a multiple probe design across behaviors during days. Furthermore, similarity between participants was provided with a set of conditions the students possess, and independence was provided by providing a tablet computer to each participant within an educational environment.

Internal validity is to show that the change that takes place in the dependent variable only depends on the independent variable. In the single-subject research methods, the main threats to internal validity are maturation, environment and features of independent variables (Cooper, Heron, & Heward, 1987; Gay, 1987). Maturation means that changes in the dependent variable may depend on the physical, emotional and mental development of the subjects as well as the independent variable. Not making Modification on research stages and not making any stages too long controls the possible effects of maturation (Kircaali-Iftar, & Tekin, 1997). In this study, in order to control the maturation total data collection process lasted approximately 40 days. Environment is the second threat for internal validity. In the single-subject research methods, generally, the education that the subject were participated conducted in the in real environments such as education, home, work environment; so some features of these environments can affect the experiment process (Kircaali-Iftar, & Tekin, 1997). This study was conducted in a classroom in participated students' school which is an education environment. The participated students were familiar with the environment and in every process of the study, the same classroom was used to eliminate the environment threat for internal validity. Environmental setting of the study was explained in later sections. The last threat is features of independent variables. It must be determined which dimensions of the independent variable are responsible for the change that occurs in dependent variable. For that, the independent variable should be applied as it is planned (Kircaali-Iftar, & Tekin, 1997). In this study, the independent variable was the concept-teaching application named "Shape Finder" that was used to teach the three shapes (cube, cylinder, and cone) within the context of a multiple probe design across behaviors during days. Therefore, all steps for teaching the cube, cylinder and cone shapes were conducted as planned.

### 3.3. Researcher's Role

In qualitative studies, the researcher is the key instrument (Creswell, 2009; Yin, 2011). Researchers can collect data with many different methods such as observation, interview or document analysis from various sources. Besides the use of these different instruments, by following protocols for data collection, researchers are also in themselves another type of data collection instrument. A researcher's duty during a qualitative study is to collect data, to analyze the data, and also to present the results from the researcher's perspective. These additional tasks deliver additional challenges and researchers must possess certain skills such as listening, asking enough questions, expertise in the subject area, observing the data, parallel processing, and perseverance (Yin, 2011). According to Denzin and Lincoln (2008), researchers are human instruments; therefore, the participants of the research should also be aware of the role of these human instruments. Moreover, the qualitative researcher must represent the relevant aspects of self, including any prejudices and assumptions, experiences, and expectations in order to describe their ability to carry out the study (Greenbank, 2003).

At the beginning of the study, the researcher presented her biography to the participants and explained how this research had originated. The researcher is a Ph.D. candidate at the Computer Education and Instructional Technology Department of the Faculty of Education at a public university in Ankara, Turkey. She received her B.Sc. degree from the same department at the same university, and took several courses related to instructional technology and educational research. Also, she attended several courses related to special education methods and technology usage in special education from the Special Education Department of a different public university in Turkey. Moreover, she also attended a teaching internship at a school determined by the Special Education Department for their undergraduate students in order to observe the learning environment of students requiring special education and their condition-based needs. The role of the researcher was presented to participants during the data collection process. At the beginning of the teaching and data collection processes with tablet computers, a Parent Consent Form was sent to each participant students' parent (see Appendix A). Also, at the beginning of the interviews, an Informed Consent Form (see Appendix B) was given to each interviewee. In order to gather observational data, the researcher attended all sessions of the study and observed the students' ability to use the application and their tablet computers. At the beginning of the probe and baseline data collection sessions, the role of the researcher in the classroom was explained to the participant students, and a brief representation about the researcher's biography was made.

Emergence of this study is based on the younger sibling of the researcher, who was born in 2001. The researcher's brother has some intellectual disabilities and was diagnosed with moderate intellectual disability following a region in his brain that suffered oxygen deprivation at birth, also known as birth asphyxia. As a consequence, he has some neurological developmental issues, has certain difficulties in verbal communication, as well as understanding some situations, and with socializing. This real-life familial circumstance led the researcher to seek different solutions for her brother's education, and therefore to the instigation of the current study.

Furthermore, due to the educational background and interests of the researcher, she has also played a key role in the design and development of the application. As previously mentioned, the researcher took certain courses about special education methods; and therefore took on the design responsibility for the Shape Finder application. The application was designed by the researcher under the supervision of the study's co-advisor, whilst the technical development was realized by a programmer. All testing of the application was performed by the researcher.

### 3.4. Participants of the Study

Participants of the study consisted of three groups. Each group was formed with 10 students with intellectual disabilities, three special education teachers who taught the student participants, and six special education experts. Three of the special education experts are teachers in different special education schools, whilst two are Research Assistants at a university in Ankara, and one is a teacher at the General Directorate of Special Education and Guidance Services of the MoNE.

Participants of the study were determined according to purposive sampling, which is one of the non-random sampling methods whereby researchers select participants based on characteristics (Creswell, 2007, 2009; Fraenkel, Wallen, & Hyun, 2012; Miles & Huberman, 1994). Purposive sampling is the main sampling method of qualitative research. According to Creswell (2007, 2009), it is designed to help researchers better understand the problem and research questions. This means that the individuals selected by the researcher can purposefully inform an understanding of the research problem and central phenomenon in the study.

Çankaya Special Education Vocational Education Center (School) (Çankaya Özel Eğitim Mesleki Eğitim Merkezi [Okulu]) in Ankara was selected as the participant institution. The mission of the school is to improve the basic life skills of individuals who have not attained the age of 23 with mild intellectual disability, to ensure their compliance with the society, to acquire knowledge and skills about work and profession. Totally 27 teachers are working in this school and 78 students were in this school.

In order to select student participants for the study, interviews were conducted with teachers who work in the selected special education institution. In these interviews a General Information Form (see Appendix C) was used to learn about the concepts and skills that the students possess. The form contains questions about the students such as their forename, surname, IQ level, grade, and the concepts that are known and not known for each student. In the direction of these interviews, students with mild intellectual disabilities who volunteered to participate in this study and have the required pre-requisite concepts and skills were selected. The pre-requisite concepts and skills of the participants are listed as follows:

- Able to read and write;
- Labels and distinguishes at 100% level the concepts of triangles, squares, circles, and rectangles from two dimensional geometric shapes when examples are shown and asked, “What is this?”
- Fulfills the guidelines;
- (In expansion activities) Able to label the red, green colors, book, table, box, blackboard, pencil, rubber concepts and in, on, under, near which are the prepositions of place;
- Able to use a tablet computer.

Students with mild intellectual disabilities are also termed as having been diagnosed with educable mental disorder. In mental disorder classification, mild intellectual disability is selected because they are deemed educable. According to the Ministry of National Education (2013b), students with mild intellectual disabilities can be educable with limited-level educational support services and certain special arrangements.

Some of the students participated in a pilot study in order to test the developed technology-based material, and some participated in the main study to learn the determined concepts by using this technology-based material. Participants of the pilot study were four students with mild intellectual disability and one special education teacher who helped in participant selection for the study. The teacher is female and participated in the social validity part of the study. She helped to select the four students for the pilot study. Each of the four students were male, and were studying in their 10th grade as students at the Çankaya Special Education Vocational Education Center. One of these students also has a physical disability concerned with use of his hands and arms; however, he was willing and capable to participate in the study. Each pilot participant could fluently read and write, and could distinguish and label the 2D geometric shapes of a triangle, square, circle, and rectangle. Each had knowledge of the concepts of color, table, book, board, box, pencil, rubber, under, on, in, and near that were used in the expansion activities.

Participants of the main study were six students with mild intellectual disabilities and two special education teachers. The teachers helped in the selection of the six students who attended the main study. One of the teachers was female and other was male. Three of the students were male and three were female, and all were 12th grade students attending the Çankaya Special Education Vocational Education Center.

At the beginning of the main study there were six students, but two withdrew from the study due to a lack of attendance to school on the days of the study's application. At the end of the study, one male and three female students had participated in all steps of the study. Parent Consent Form (see Appendix A) was signed by all participant students' parents. During the study, names of participated students are not used; predetermined user names were used in the main study. These names are Student-1, Student-2, Student-3 and Student-4.

Student-1 was born in 1999, he is male and having mild intellectual disability. His intelligence quotient (IQ) level was 55. He was attending to the school every day. He is good at academic skills in the school, he can read and write. He can distinguish and label 2 dimensional geometrical shapes which are square, triangle, rectangle and circle.

He also distinguishes red, green colors, book, table, box, blackboard, pencil, rubber concepts and in, on, under, near which are the prepositions of place. He can able to use tablet computer.

Student-2 was born in 1997, she is female and having mild intellectual disability. Her intelligence quotient (IQ) level was 50. She was attending to the school every day. She is good at academic skills in the school, she can read and write. She can distinguish and label 2 dimensional geometrical shapes which are square, triangle, rectangle and circle. She also distinguishes red, green colors, book, table, box, blackboard, pencil, rubber concepts and in, on, under, near which are the prepositions of place. She can able to use tablet computer.

Student-3 was born in 1997, she is female and having mild intellectual disability. Her intelligence quotient (IQ) level was 55. She was attending to the school every day. She is good at academic skills in the school, she can read and write. She can distinguish and label 2 dimensional geometrical shapes which are square, triangle, rectangle and circle. She also distinguishes red, green colors, book, table, box, blackboard, pencil, rubber concepts and in, on, under, near which are the prepositions of place. She can able to use tablet computer.

Student-3 was born in 1999, she is female and having mild intellectual disability. Her intelligence quotient (IQ) level was 60. She was attending to the school every day. She is good at academic skills in the school, she can read and write. She can distinguish and label 2 dimensional geometrical shapes which are square, triangle, rectangle and circle. She also distinguishes red, green colors, book, table, box, blackboard, pencil, rubber concepts and in, on, under, near which are the prepositions of place. She can able to use tablet computer.

### 3.5. Environmental Setting

Whole study was conducted in a class in the Çankaya Special Education Vocational Education Center. The setting of the class was given in Figure 2. In the baseline, probe data collection sessions and training sessions, all students were in this classroom at the same time. However, in the data collection about Real Objects sessions, students were taken to the class one by one, because the students should not see each other while performing the conditions asked about Real Objects. One of the teacher of participated students was also in the class while collecting the data. However, the teacher did not get involved in any session of the study.

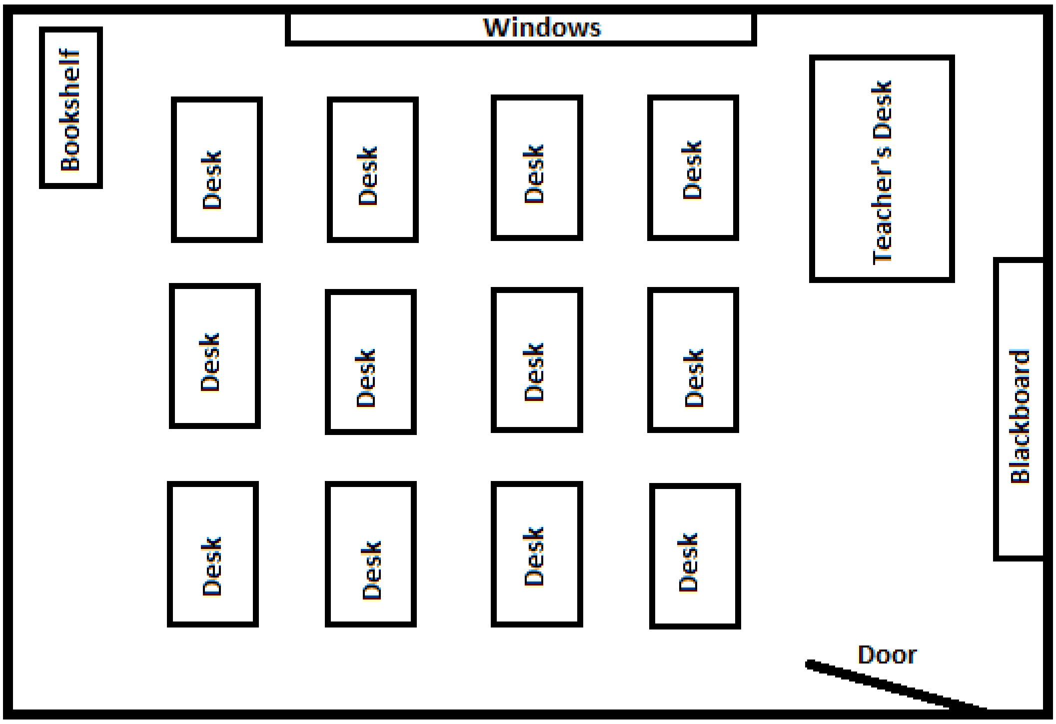


Figure 2: Environmental Setting of the Class

### 3.6. Application Design Process

The tablet computer application used in this study was designed by the researcher and her Ph.D. co-advisor according to the Direct Instruction Method. The researcher's co-advisor was an Associate Professor at the Special Education Department of Gazi University in Ankara. With the increasing usage of technology in education, there is an emerging need for tablet computer applications especially within special education; because in order to able to use these technologies in the special education classroom, they need special applications suited to the needs of the students. With that purpose in mind, the tablet computer application named Shape Finder was developed. With the first version of the application, a pilot study was conducted with four male students using the application for a period of one hour. The main aim of the pilot study was to ascertain whether or not the students were able to use the application without interference or assistance.

In the pilot study, firstly an interview was conducted with one special education teacher, followed by application of the General Information Form (see Appendix C). As previously mentioned, four students were selected for the pilot study. The primary purpose of the pilot study was to determine any problems or any incompleteness with regards to the tablet computer program that developed for the teaching of cube, cylinder, and cone shapes to students with ID. For that purpose, iPads and earpiece-style headphones were distributed to the pilot students and then they were observed without interference. The researcher's observations were recorded using the Observation Form (see Appendix D), which was designed for this study in order to examine every step of what the students did when using the Shape Finder application. Also, the students' responses to the questions in Shape Finder were stored by the application in order that the researcher could examine them to ascertain how many right answers each of the students gave. Students finished the whole application in one hour, having played every step for each of the three concepts; cube, cylinder, and cone shapes. At the end of the observation process, data from the observation form showed that there was some part of the application that should be further developed and that certain directions should be added to the application voice in order to instruct users what they should do on some screens.

The students' teacher used also the application in order to be able to provide advice, when necessary, to the students. At the end of the pilot usage, the students stated that they liked the application but that they experienced some problems. The issues raised were the waiting time for the training and balloon screens, reentry of incorrect answers, and the need for additional voiceover guidance for some screens about what users should do on these screens.

The application was subsequently updated according to the issues raised in the pilot study. Each screen of the application, plus the integration of the Direct Instruction Model to this application are illustrated in Figures 3-20:

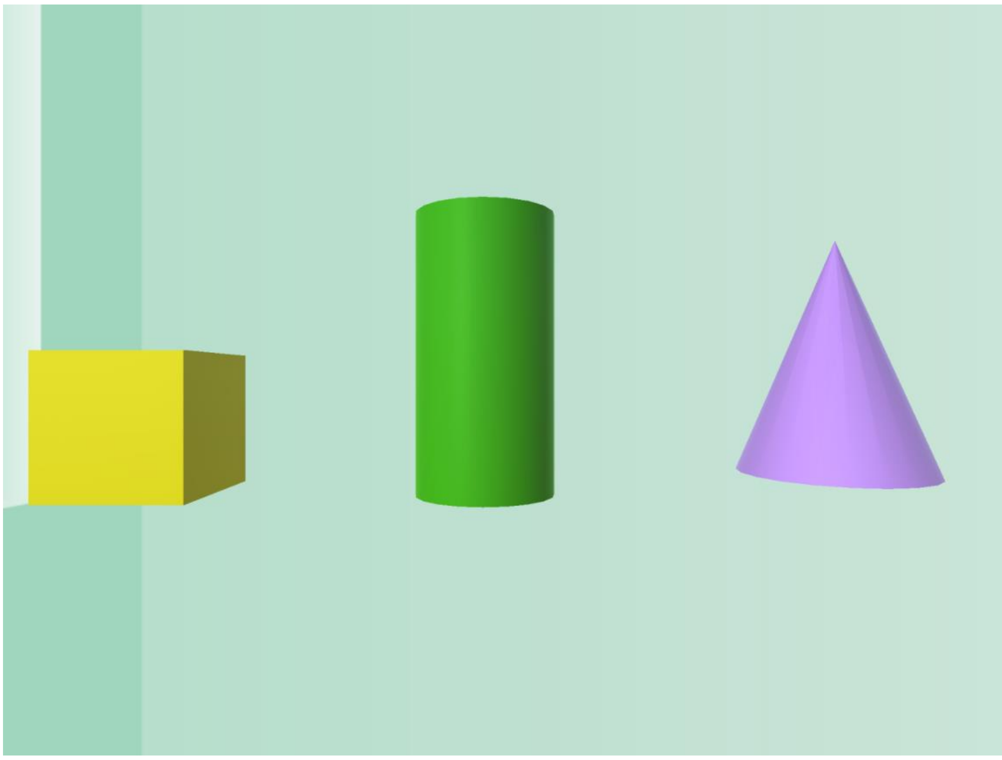

Figure 3: Shape Finder application: Splash screen

On the splash screen (see Figure 3), the three geometric shapes that are to be taught in this application are presented. This screen remains for approximately 10 seconds, and is then replaced by the login screen.


Figure 4: Shape Finder application: Login screen

When the user accesses this screen which is shown in Figure 4, the application voice says, “Hello, choose your name from the list. If your name is not on the list, touch the Add New User (Yeni Kullanıcı Ekle) button and enter your forename and surname.” After the application voice, the screen remains until the user selects their name from the list, or the user selects the Add New User button. If the user touches the button, a new screen is launched, the Add New User screen, which is shown in Figure 5.

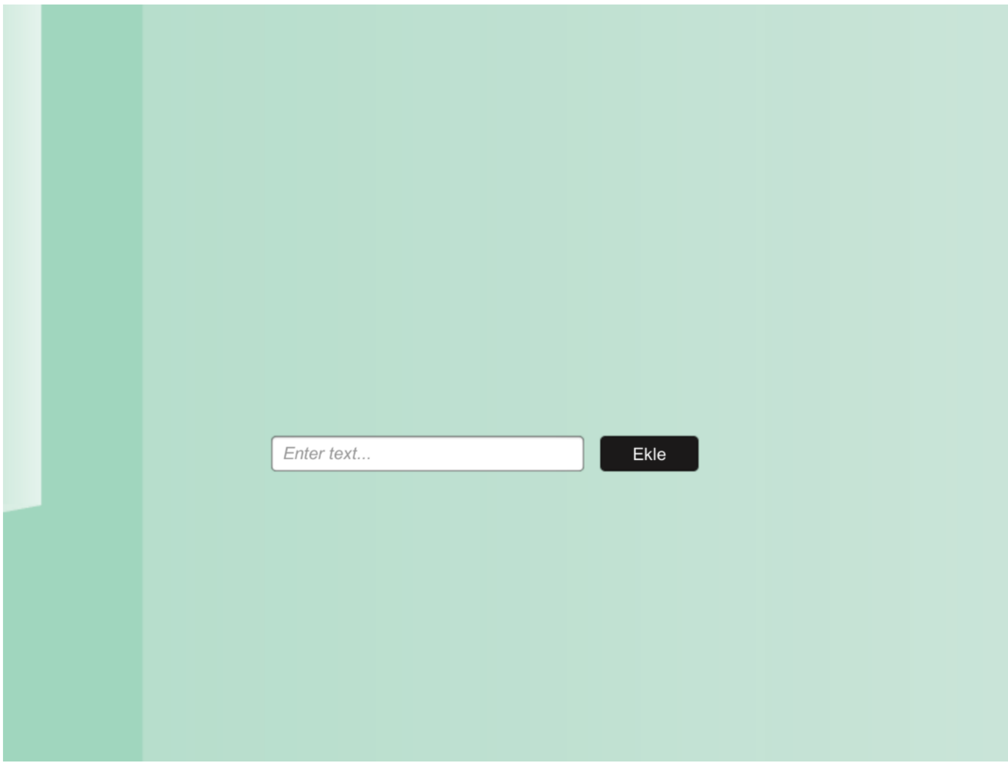


Figure 5: Shape Finder application: Add New User screen

On the Add New User screen (see Figure 5), the application voice says, “Write your forename and surname in the blank space and touch the Add button.” When user touches the white space, the tablet computer’s keyboard is shown on the screen and the user can then enter their forename and surname. After entering their name data, the user should touch the Add (Ekle) button; then the training part of the application will launch.

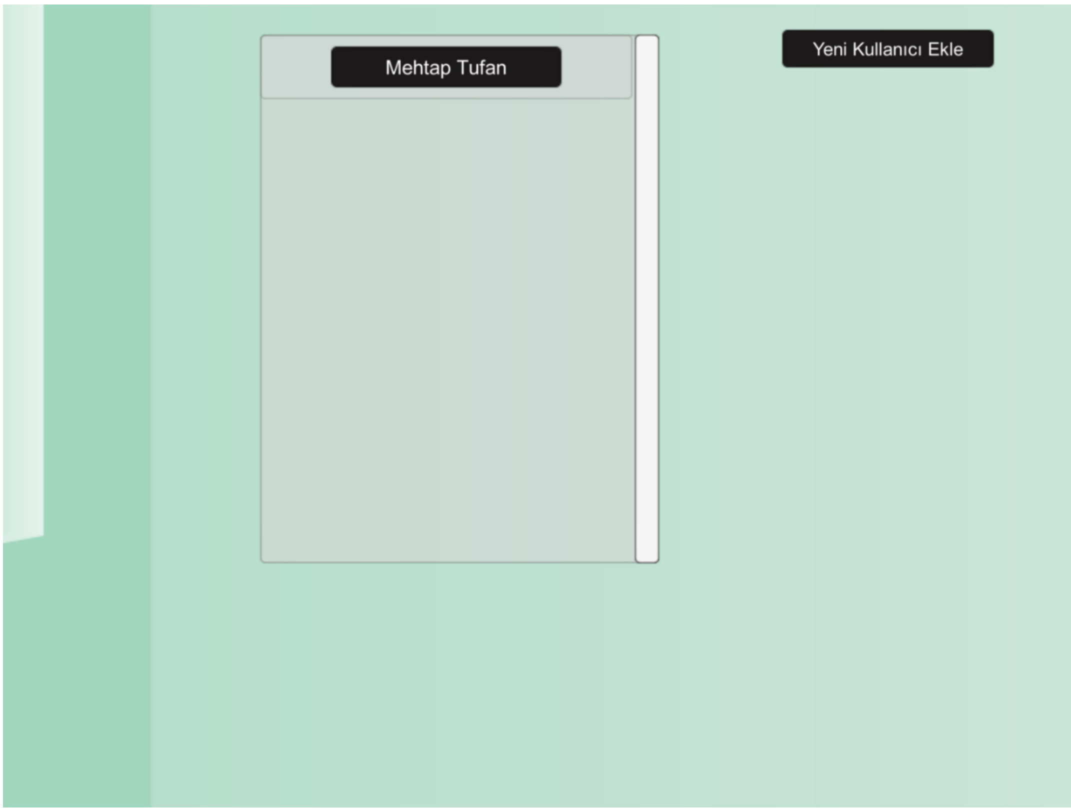


Figure 6: Shape Finder application: Login screen (with name)

If the user's forename and surname is shown on the list (see Figure 6), the users can select their own name to launch the User Option screen (see Figure 7), which contains options of Start the Training, Play Games, and See the Reports.

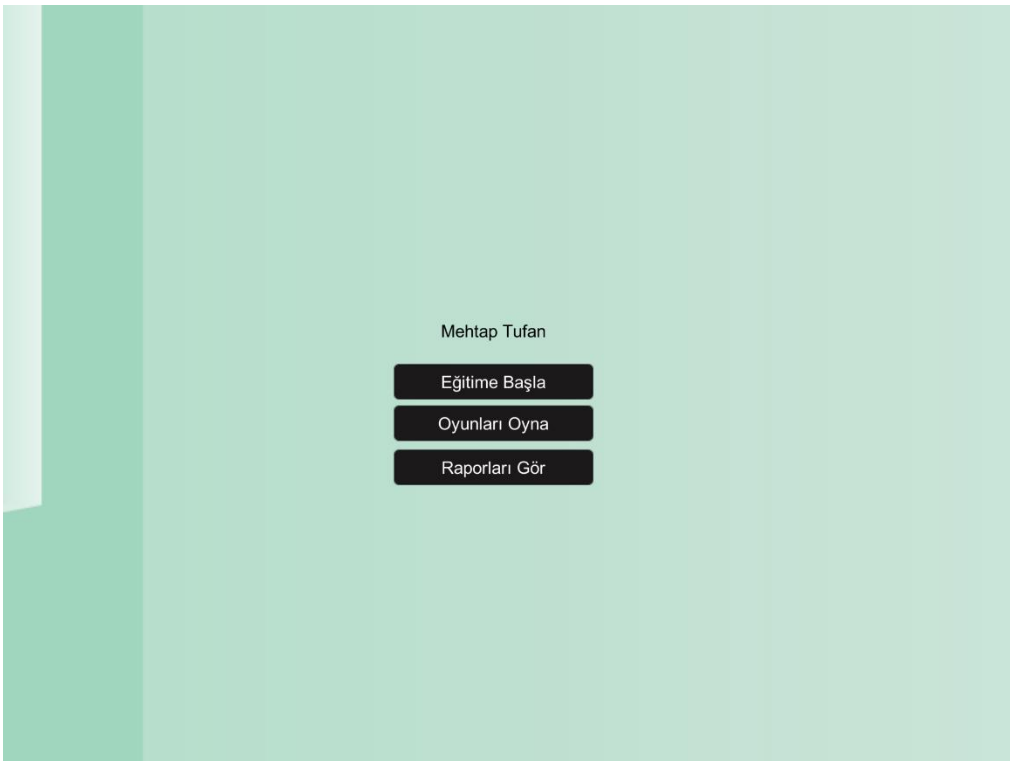


Figure 7: Shape Finder application: User Option Screen

If the user closes the application in some way, the application can restart at the point where the user left off before closing the application. Also, if the user had completed the training, they can continue to play the games related to the geometric shapes by selecting the Play the Games (Oyunları Oyna) button. Alternatively, the user may opt to view the results of their training and/or games by touch selecting the Reports (Raporları Gör) button. For example, the users may wish to see how many mistakes they made, if any, for each geometric shape, and how many seconds it took them to place each shape in the correct position.

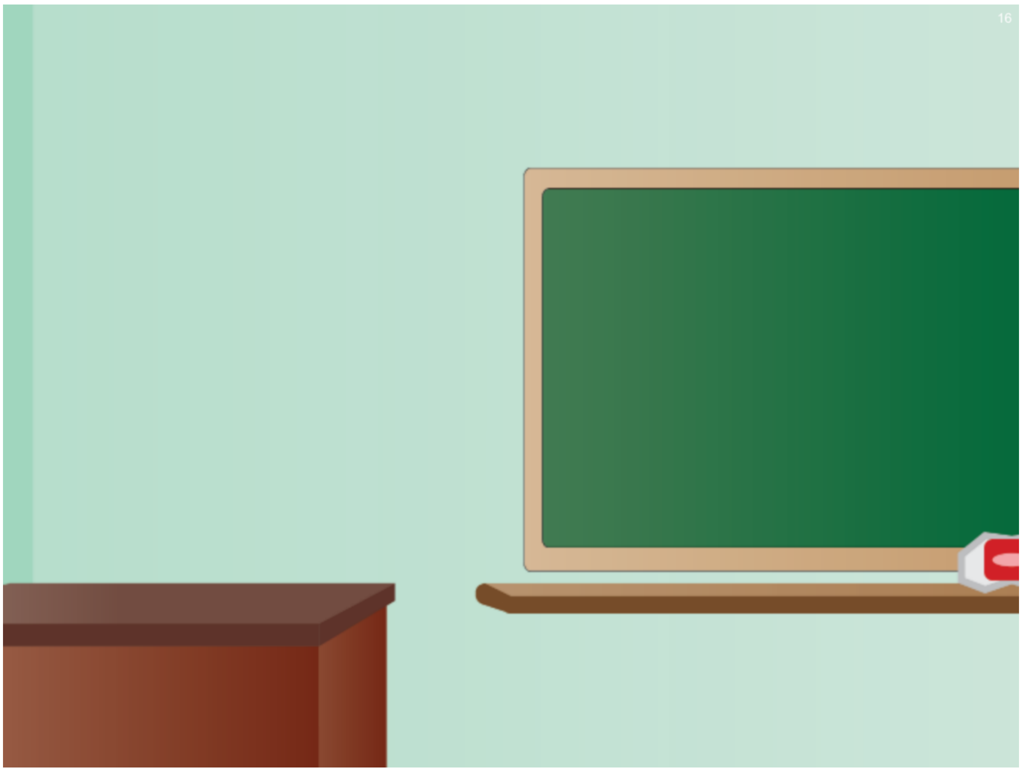

Figure 8: Shape Finder application: Main screen

After the user enters their forename and surname and touches the Add button, the application automatically launches the training and evaluation section of the application, starting with the Main screen, which is shown in Figure 8. For each geometric shape, the application voice introduces and explains what the user is tasked to do on the screen:

> *Now, you will learn the cube shape, which is one of the 3-dimensional geometric shapes. Firstly, I will show you the cube shape, and then I will show you how to write the name "cube." Then I will show some shapes and ask you what their names are, and you can write the name of the shape that you see.*

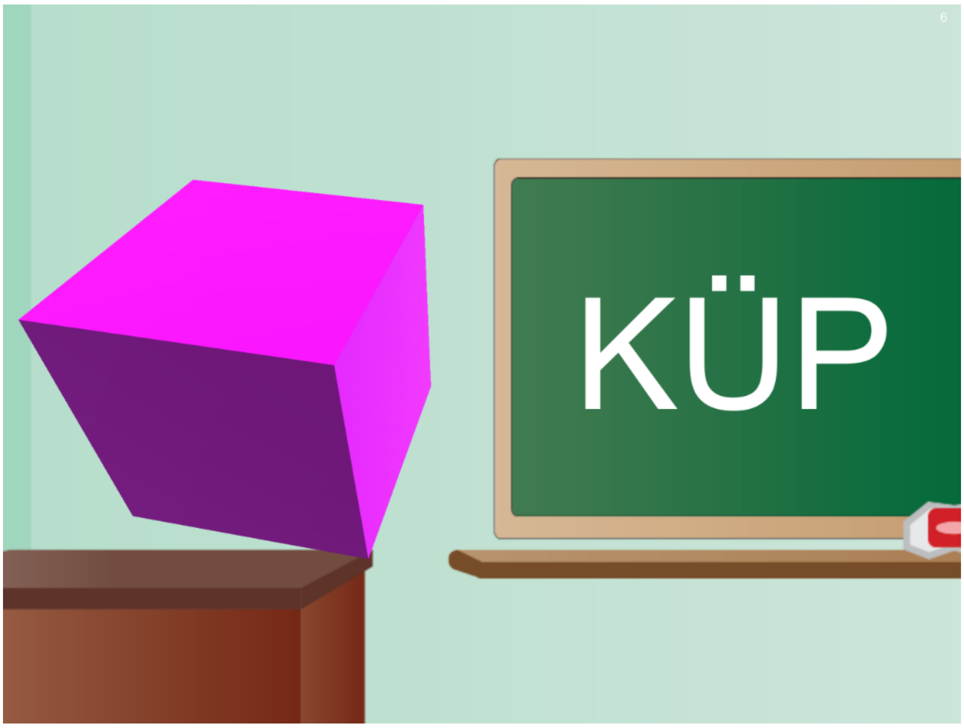


Figure 9: Shape Finder application: Cube shape first training screen

After the initial voiced introduction, the application launches the main training section. For each 3-dimensional geometric shape, which are the cube, cylinder, and cone, there are two training sections. In the first training section, the shapes are presented as the same size, but with different colors. In Figure 9, the cube shape first training screen can be seen, with a purple cube (note: a different colored shape appears on each start) and its name is written on the board. Also, the application voice says that, “Cube-shaped. Touch the shape, rotate it around and look at which shape it is.” In this section, three different colored cube shapes are shown and the application voice repeats the same sentence. Each cube is shown for a period of 15 seconds on the screen in order that the user can focus on the cube shape and how its name is written.

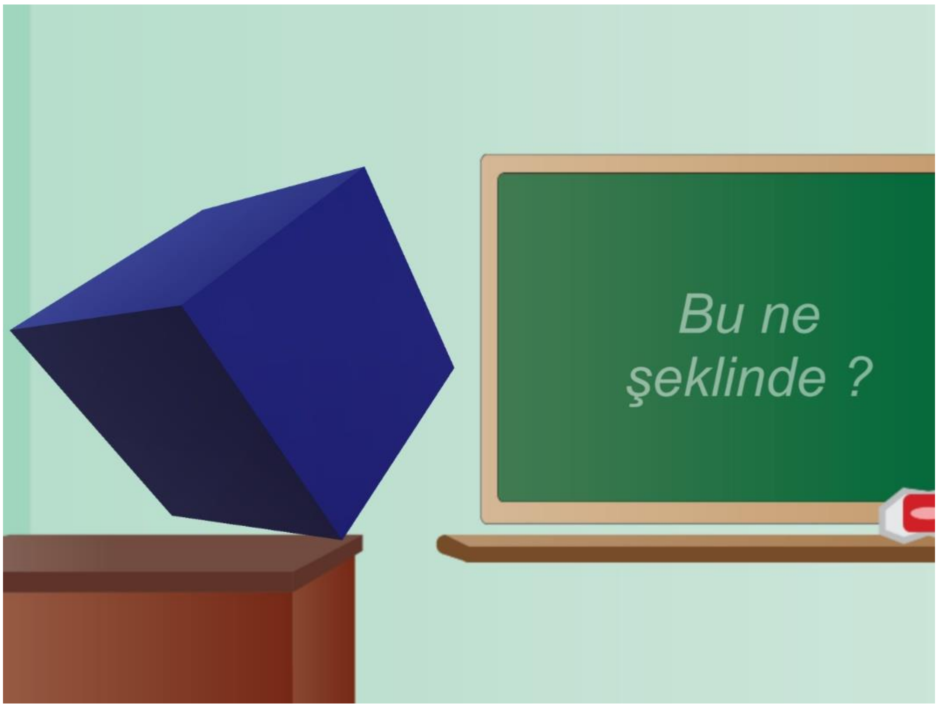


Figure 10: Shape Finder application: Cube shape first evaluation screen

When the cube shape first training section ends, the evaluation section automatically starts (see Figure 10). For each shape the application voice asks, “Which shape is it?” and “Touch the board and write its name.” The user can also rotate the shape around in order to look at what shape it is. When the user touches the board, the keyboard appears on the screen and the user can then write the name of the shape. In the evaluation section, there are 10 questions which consist of seven positive and three negative examples of the cube shape. The negative examples consist of square, triangle, and rectangle. If the user makes two or more mistakes, the application adds a small training section with five questions and it also asks one more question for each incorrect answer in the trainings’ evaluation section.

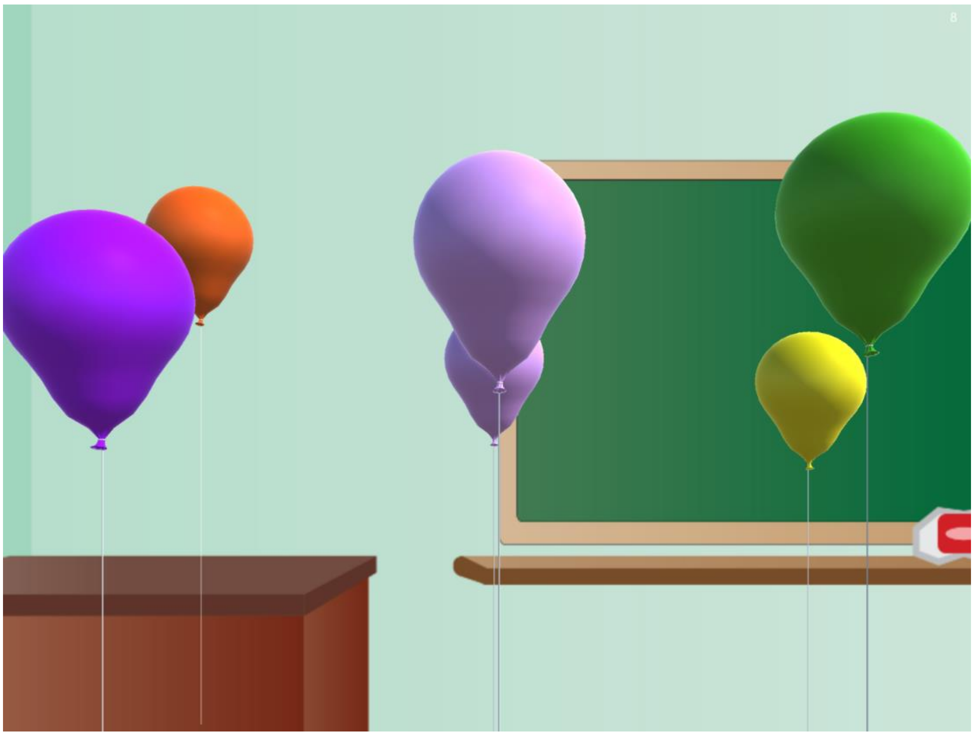

Figure 11: Shape Finder application: Correct answer reinforcement screen

In each of the evaluation sections, when the user enters the shape's name correctly, the application voice provides verbal reinforcements such as, "You were very successful," "Well done," "You are doing really well," and "You are super." After that, balloons are seen to float up from the bottom of the screen and the application voice says, "Let's touch and pop the balloons" (see Figure 11). When the user touches the balloons, they will pop and the application will make a "boom" sound for the user to hear. If the user does not touch any of the balloons, nothing will happen. When all of the balloons disappear from the screen, the application will pass to the next question, or if all the questions are finished, it will move on to the next section.

On the other hand, if the user incorrectly writes the name of the shape, then the application will provide some additional training on the same shape as reinforcement. The same shape will again be seen on the screen, together with the name of the shape that will be shown written on the board. The application voice will say, "This is cube-shaped." After that, the application will ask the same shape again, in order to make sure that the user understood it correctly. Each answer is saved by the application automatically, so that at the end of the user's session they can see how many correct and incorrect answers they made. When user has finished all questions in the first training's evaluation section, the application will move on to the second training section.

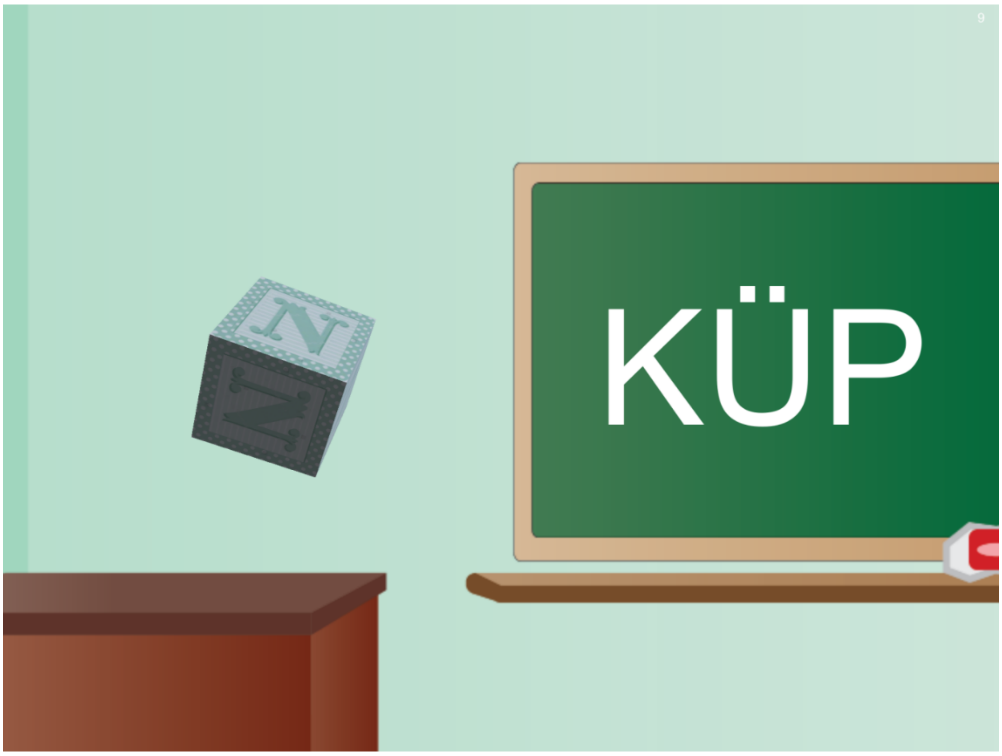


Figure 12: Shape Finder application: Cube shape second training screen

The second training section screen is identical to the first, except in this section the cube shape's design and size are different, as can be seen in Figure 12. In this section, the cube shapes are designed according to real world cube shapes and include different sizes. Therefore, users can generalize the concept for each different cube shape. In the second training, there are again three cube shapes, each of a different size and different design. The application voice says for each shape, "Cube-shaped. Touch the shape, rotate it around and look at what shape it is," and the word "Cube" is written on the board for each example. The training method is an exact match to the first training section and this method is also used for the other two concepts of cylinder and cone.

Each concept remains on screen for a period of 15 seconds in order that the user can focus on the shape and see how its name is written.

After the cube's second training section is complete, the application will ask the user 10 questions; three of them are negative examples consisting of square, triangle, and rectangle, and seven are positive examples of the cube shape. Again, this evaluation section is an exact match with cube's first training's evaluation section; the only difference being that the cubes are created with different sizes and different designs. Also, if the user makes two or more errors, the application adds a short training section with five questions, and also asks one more question for every incorrect answer in the trainings' evaluation sections. When the user gives a correct answer, the application voice adds some verbal reinforcement and balloons are shown to float up from the bottom of the screen in order to motivate the user. If the user gives an incorrect answer, the application will add a short training section about the same shape, and then it will again ask the same shape to the user. This situation is exactly the same for each question.

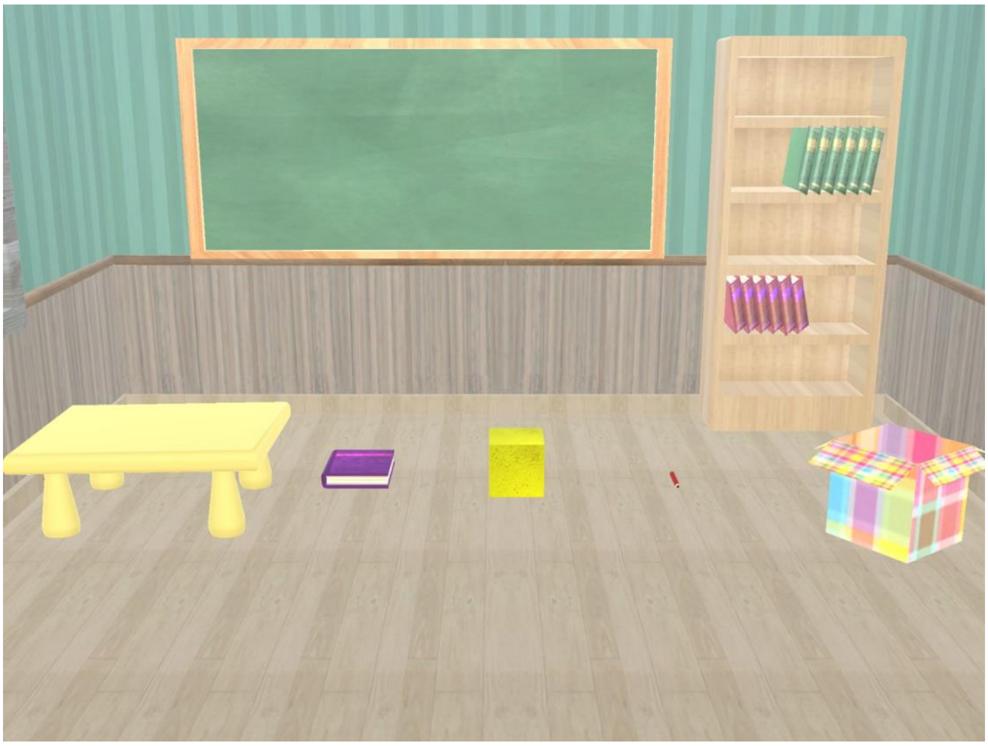

Figure 13: Shape Finder application: Cube shape generalization game

At the end of the cube shape second training and evaluation section, the cube shape generalization game will launch. As can be seen in Figure 13, in this section three different objects have fallen from the top of the screen, of which one of the objects will be cube-shaped. Other shapes may be books, pencils or rulers, which are all concepts that the user had verified as knowing prior to the commencement of the study's application. When the generalization game screen is opened, the application voice makes an introductory speech in order to explain what the user will be tasked to do, saying that, "Now we will play a game about the cube shape. I will tell you where to put the cubes, and you will touch the cube shapes and put them in the right place where I said." After this explanation, the application voice will state one of the following places:

- Put the cube under the table
- Put the cube on the table
- Put the cube under the board
- Put the cube in the box
- Put the cube near the red books
- Put the cube near the green books.

The application gives 10 instructions selected randomly from this list of places. The application stores how many seconds it took for the user to place the correct-shaped object in its correct position. If the user touches an incorrectly shaped object, then the application provides the user with a hint in the form of an arrow pointing towards the cube-shaped object.

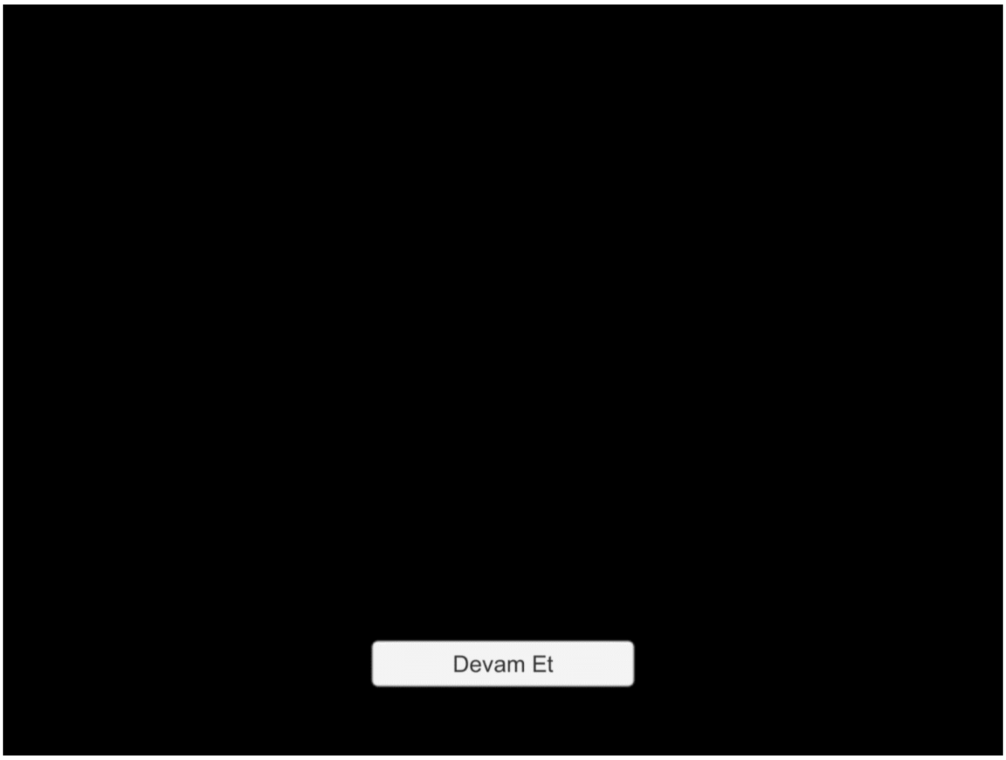


Figure 14: Shape Finder application: Start screen to select next shape

At the end of the two cube shape training and evaluation sections and the generalization game, the application provides the user with a one minute break and a black screen is shown, then the “Continue” (Devam Et) button appears as can be seen in Figure 14. In the study, each shape is taught on a different day, so the Start screen is also used to end the training for each day. When the user closes the application and reopen it on a different day or at a later time; by selecting their name from the user list, the application will resume the training from the point where they left off. Having completed the cube shape training and evaluation, when the user touches the continue button, the application will open the cylinder shape first training screen, as seen in Figure 15.


Figure 15: Shape Finder application: Cylinder shape first training screen

The cylinder shape first training screen (see Figure 15) is an exact match to the cube shape first training screen. The application voice makes the same introductory speech, and the application provides three positive examples with the shape names written on the board. The application then asks the user 10 questions, of which seven are positive examples and three are negative like square, circle, and triangle, or also cube. The cube shape is also given as a negative example in this training because it was previously learned, thereby providing the user with the opportunity to repeat and remember the cube shape.


Figure 16: Shape Finder application: Cylinder shape second training screen

Figure 16 shows the cylinder shape second training screen. On this screen, each step matches that of the first shape training which was the cube. The only difference is the design and size of the cylinder shapes. Here too there are 10 questions, of which three are negative and seven positive. If the user makes two or mistakes in the questions, the application provides a short training with two examples and asks five additional questions to the user. The application's reaction to the answers is exactly the same as with the cube shape training.

Figure 17: Shape Finder application: Cylinder shape generalization game

After the two main training sections for the cylinder shape, the application passes automatically to the cylinder shape generalization game, as seen in Figure 17. This game is the same as the cube shape generalization game, but with one small difference in that the cube shape has also fallen down from the top of the screen as a negative example of cylinder shape. This encourages the user to remember the cube shape and to differentiate it from a cylinder. In this game, the user should follow the instructions given by the application voice which states a place selected at random from the following list, and repeats this action 10 times:

- Put the cylinder under the table;
- Put the cylinder on the table;
- Put the cylinder under the board;
- Put the cylinder in the box;
- Put the cylinder near the red books;
- Put the cylinder near the green books.

At the end of two cylinder shape trainings and evaluation sections and the cylinder generalization game, the application provides a one minute break with a black screen, and then the “Continue” (Devam Et) button appears as shown in Figure 14. When the user touches the continue button, the application moves to the third and final concept training, which is the cone shape.

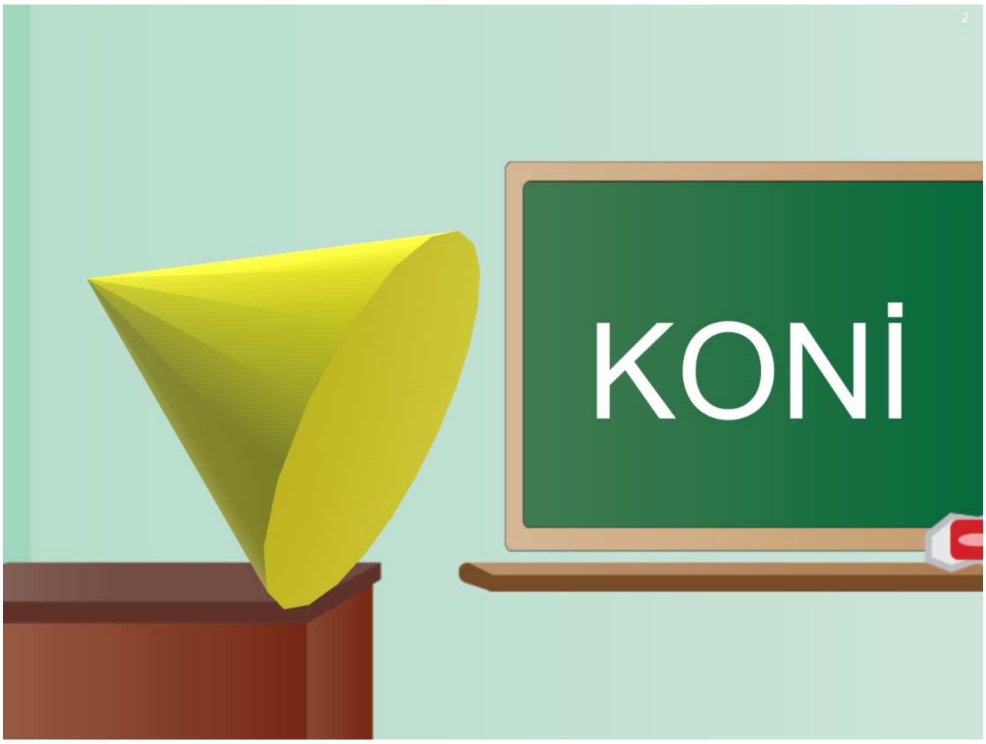


Figure 18: Shape Finder application: Cone shape first training screen

The cone shape first (see Figure 18) and second training and evaluation steps are the same as for the cube and cylinder shapes. Correct and incorrect answer reactions are also the same as for the other shape’s evaluations. For the cone shape, the only difference is that the cone shape generalization game differs from that of the cube and cylinder shapes.

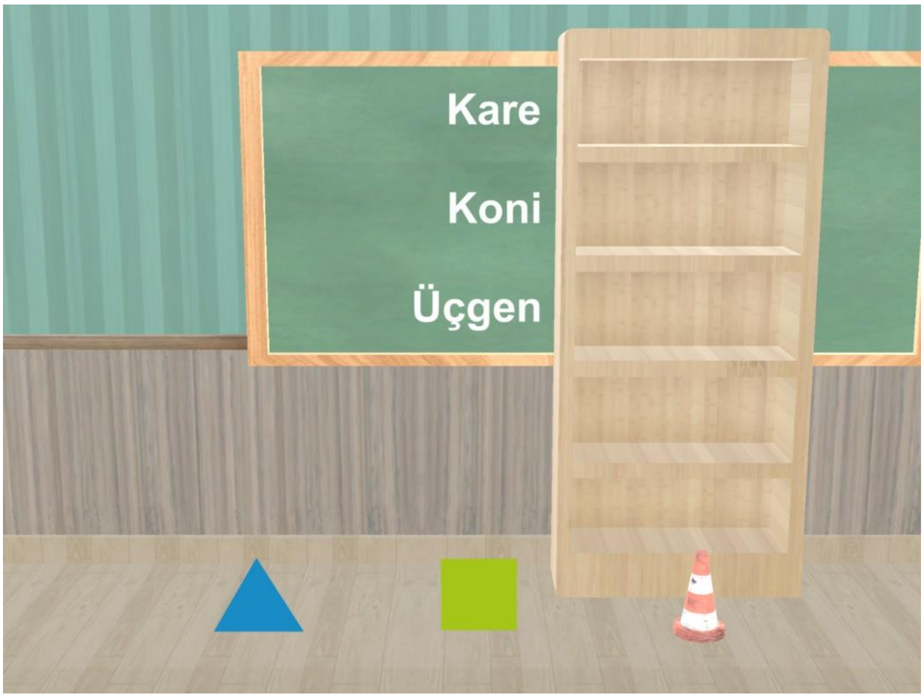


Figure 19: Shape Finder application: Cone shape generalization game

The cone shape generalization game is a shape matching game, as seen in Figure 19, in which the user is tasked with matching shapes with their corresponding name. Three different shape names are written on the board and three shapes are shown to fall down from the top of the screen. The user should touch the shape and place it on to the correct shelf nearest the corresponding name of the shape. The application sets this matching task 10 times; picking three shapes randomly from cube, cylinder, cone, square, triangle, circle, and rectangle shapes. If the user correctly matches the names with shapes, then application voice provides verbal reinforcement such as, “You are very successful,” “Well done,” “You are doing really well,” and “You are super”; but if the user places any of the shapes to the incorrect shelf, then the application will not move on until the user corrects the error. In this game, the application stores the number of seconds that the user spends while placing all of the shapes onto the correct shelves.


Figure 20: Shape Finder application: Report screen

After the user has completed all of the steps for each of the shapes, the application automatically opens the Report screen for the user, as seen in Figure 20. "Cube1" shows the cube shape first training evaluation results. As can be seen in the example in Figure 20, there are results shown for 11 questions in total; this is because the user made a mistake, hence the application added one additional question. “Cube1P1” shows the short additional training evaluation result; if the user makes two or more mistakes in the cube shape first training, then the application adds a further short training session with five additional questions; the results of which are shown as “Cube1P1.” For example, in the cylinder shape first training evaluation, which are shown as “Cylinder1,” two mistakes were made; therefore, the application added a short training session with five additional questions. The results of these additional questions are shown in the “Cylinder1P1” section. “Cube2” refers to the cube shape second training evaluation results. This naming convention follows suit for each of the concept training shapes. The figure one (“1”) indicates the first training evaluation result, whilst two (“2”) indicates the second training evaluation result. The “P1” suffix indicates the results of the short training evaluation result. The result shown “game1” refers to the cube shape generalization game’s results, whilst “game2” refers to the cylinder shape and “game3” refers to the cone shape generalization game’s results.

## 3.7. Data Collection Procedures and Instruments

Data of this study were collected in January and February, 2017, using the Shape Finder application, classroom observations, and interviews. Each data collection process is explained in detail in the following subsections.

### 3.7.1. Shape Finder

The primary study was executed according to multiple probe designs across behaviors. In this design, to ensure the internal validity the pre-intervention data should be collected simultaneously for all behaviors. For that reason, probe and baseline data were collected for each shape using MS Word documents on tablet computers. A total of 30 different pictures of real objects in the cube, cylinder, and cone shapes were shown in three Word documents, with 10 pictures of real cube-shaped objects in one Word document; 10 of real cylinder-shaped objects in a second Word document; and 10 pictures of real cone-shaped objects in a third Word document. These three documents were used for probe and baseline data collection. In these documents, the participants were tasked with writing the shape’s name next to each picture in the document. This activity was named as labeling of shapes. These documents were also used for collecting sustainability data of labeling of shapes at the end of the training and evaluation with the Shape Finder application.

Training and the evaluation of this study were performed with the Shape Finder application on tablet computers. For collecting sustainability data, the participants completed the Word documents prepared for probe and baseline data collection, and generalization games designed in the Shape Finder application during the 3rd, 4th, and 5th weeks after the end of the training. Also, in order to examine the effectiveness of teaching shapes with the Shape Finder application on real objects, pre-tests and post-tests were applied with real cube-, cylinder-, and cone- shaped objects made from paper, cardboard, or plastic that the participants would come across in the real world. For each shape, 10 questions were asked to the participants with real objects according to certain context. In total, 30 questions were asked to the participants. The context and questions are listed as Questions for Generalization with Real Objects document (see Appendix E). An example of these context and questions is, “There are cube, cylinder, cone, square, sphere, and triangle shapes of the same color and same amount on the table”; then it was asked, “Place the cube shapes under the table.” These context and questions were stated at the beginning of the probe and baseline data collection days, and also at the end of the training and evaluation days with the Shape Finder application. Furthermore, in using the Shape Finder application to teach cube, cylinder, and cone shapes to the participant students, each answer given to the evaluation questions and game plays were saved by the application in order to evaluate the effectiveness of the application on teaching the concepts of the cube, cylinder, and cone shapes to students with ID.

A summary of the each day’s work is listed as follows according to the multiple probe design across behavior research type:

- Day 1: Cube shape first baseline data, cylinder shape probe data, and cone shape first probe data collected from students using MS Word documents on tablet computers (see Appendix G for an example document). Students answered the Questions for Generalization with Real Objects document (see

Appendix F) according to prepared context. All students were observed, and all answers marked on the Checklist of Real Objects' Questions (see Appendix H) separately as participants able or unable to do each item.

- Day 2: Cube shape second baseline data collected using MS Word documents.
- Day 3: Cube shape third baseline data collected using MS Word documents. This behavior was seen as stabilized and training with the Shape Finder application for teaching the cube shape concept was suitable. Earpiece-style headphones were given to the students and they accessed the Shape Finder application. The students advanced through the cube shape first training and evaluation, then the cube shape second training and evaluation, and finally the cube shape generalization game section. With this application, cube shape training and evaluation data and generalization game data were collected.
- Day 4: Cylinder shape first baseline data and cone shape second probe data collected using MS Word documents.
- Day 5: Cylinder shape second baseline data collected using MS Word documents.
- Day 6: Cylinder shape third baseline data collected using MS Word documents. This behavior was seen as stabilized and training with the Shape Finder application for teaching the cylinder shape concept was suitable. Earpiece-style headphones were given to the students and they accessed the Shape Finder application. The students advanced through the cylinder shape first training and evaluation, then the cylinder shape second training and evaluation, and finally the cylinder shape generalization game section. With this application, cylinder shape training and evaluation data and generalization game data were collected.
- Day 7: Cone shape first baseline data collected using MS Word documents.
- Day 8: Cone shape second baseline data collected using MS Word documents.
- Day 9: Cone shape third baseline data collected using MS Word documents. This behavior was seen as stabilized and training with the Shape Finder application for teaching the cone shape concept was suitable. Earpiece-style headphones were given to the students and they accessed the Shape Finder

application. The students advanced through the cone shape first training and evaluation, then the cone shape second training and evaluation, and finally the cone shape generalization game section. With this application, cone shape training and evaluation data and generalization game data were collected.

- 15-day break
- Day 24; Week 3: Students answered the Questions for Generalization with Real Objects document again as a post-test for distinguishing real objects of the concept shapes. All students were observed, and all answers marked on the Checklist of Real Objects' Questions (see Appendix G) separately as participant able or unable to do each item. In order to examine the retention of the learned shapes, MS Word documents were used in labeling the shapes. In addition, cube, cylinder, and cone generalization games in the Shape Finder application were used for generalization of the shapes.
- Day 31; Week 4: In order to examine the retention of the learned shapes, MS Word documents were used in labeling the shapes. In addition, cube, cylinder, and cone generalization games in the Shape Finder application were used for generalization of the shapes.
- Day 38; Week 5: In order to examine the retention of the learned shapes, MS Word documents were used in labeling the shapes. In addition, cube, cylinder, and cone generalization games in the Shape Finder application were used for generalization of the shapes.

Procedures of each day are also given in Table 2:

Table 2
*Overview of Collected Data and Data Collection Instruments by Day*

| *Day* | *Collected Data* | *Data Collection Instruments* |
|---|---|---|
| 1 | Cube baseline data<br>Cylinder and Cone probe data<br>Generalization with Real Objects | Word documents<br>Observation<br>Checklist |
| 2 | Cube baseline data | Word documents |
| 3 | Cube baseline<br>Cube training and evaluation | Word documents<br>Shape Finder application + observation |
| 4 | Cylinder baseline data<br>Cone probe data | Word documents |
| 5 | Cylinder baseline data | Word documents |
| 6 | Cylinder baseline data<br>Cylinder training and evaluation | Word documents<br>Shape Finder application + observation |
| 7 | Cone baseline data | Word documents |
| 8 | Cone baseline data | Word documents |
| 9 | Cone baseline data<br>Cone training and evaluation | Word documents<br>Shape Finder application + observation |
| 24 (Week 3) | Generalization with Real Objects<br>Labeling of all shapes<br>Games for all shapes | Checklist<br>Word documents<br>Shape Finder application |
| 31 (Week 4) | Labeling of all shapes<br>Games for all shapes | Word documents<br>Shape Finder application |
| 38 (Week 5) | Labeling of all shapes<br>Games for all shapes | Word documents<br>Shape Finder application |

### 3.7.2. Observation

Observation is a method used to describe behavior in detail. Observation method can be used to obtain an image of detailed (Balcı, 1995), comprehensive and time-spread behavior that occurs within any environment (Yıldırım & Şimşek, 2006). Observation is oriented to obtain data directly, unlike reporting by a third party (Karasar, 1991). Kırcaali-İftar (2003) states the basic stages of observational research as determination and identification of variables to be observed, determination of observation record type and preparation of appropriate record form, calculation of inter-observer reliability, taking necessary measures to ensure neutrality of the observer, and the nature of the observations. Data obtained from observations are largely useful in providing additional information (Yin, 2009). The researcher can take on different roles in purpose-based observations during the data collection process from a non-participant though to a full participant (Creswell, 2009; Yin, 2011). Field notes about content, context, participants, and their behaviors and activities can be taken by the observing researcher (Creswell, 2009).

In this current study, observations were used as the secondary data collection method to observe students' behaviors and activities during their usage of the Shape Finder application, and to collect data about whether or not they were able to correctly label and distinguish the shapes of real world objects. The researcher led a completely passive role during the observation data collection process. The main purpose of the observation was to understand how students used the Shape Finder application, and how they reacted while using the application and real objects. The Observation Form (see Appendix D) was used to record the researcher's observation of the students while using the Shape Finder application, and the Checklist of Real Objects' Questions (see Appendix H) was used to record the answers of students to real objects' questions. Field notes were also taken by the researcher during the observation processes.

The Observation Form consisted of the steps that the students should follow while using the Shape Finder application, behaviors such as having fun, smiling, embarrassment, tarrying, or wanting to finish the application that the student exhibited.

Therefore, the students' condition was observed to support the saved in the Shape Finder application and to see what students did while using the application.

### 3.7.3. Interviews

In many qualitative research studies, interviews may be performed in order to gain perspective and depth to the data obtained by observation. In qualitative research, the collection of data in more than one way is used in confirming and supporting the validity and consistency of the results reached (Yıldırım & Şimşek, 2006). In this study, data were also collected by interview technique in addition to observational data.

Interview is a method used to elicit answers from interviewees, with questions that are directed verbally by a researcher to each interviewee, and all information is recorded (Arıkan, 2000; Kaptan, 1995). Interviews are one of the most important data sources of qualitative studies. There are two main points to consider when conducting an interview: maintaining a sincere conversation so as not to restrict the interviewee, and meeting the needs of the research question(s). In other words, interviews should consist of guided conversations, and not just question-answer sessions or structured inquiry (Yin, 2009).

The interviewer may collect data by keeping notes in abstract form at the time of the interview or immediately after, checking the options on the prepared interview guide or using audio/video recording devices (Karasar, 1991; Creswell, 2003). Interviews are commonly grouped into three categories: "structured interview," "semi-structured interview," and "unstructured interview" (Ekiz, 2003; DiCicco-Bloom & Crabtree, 2006).

In this study, data were obtained through semi-structured interviews. In the semi-structured interview, a series of questions are prepared to be asked in a certain order prior to the interview (Ekiz, 2003; Ergenekon, 2004). By asking the prepared questions in the same way, it is possible for the participating interviewee to respond in a detailed manner but in a manner as they see fit (Ergenekon, 2004). Semi-structured interviewing allows for the rearrangement and discussion of questions to be asked by providing partial flexibility to the interviewees (Ekiz, 2003). During interviewing, questions may not be asked again (repeated), or additional questions asked by the researcher when a question has been fully answered. The interviewer may, however, make additional comments on questions put to the interviewees (Yıldırım & Şimşek, 2006).

Interviews were prepared in order to determine the opinions of students, teachers, and experts participating in a survey about the Shape Finder application. To gather the opinions of students about the Shape Finder application, seven questions were prepared. In addition, nine questions were prepared for the teachers, and nine for the experts. Each interview question was prepared in the Turkish language as the mother tongue of all participants. Some questions were similar for each participant group, but there were also questions that were specific to each group according to the information to be collected. All interview questions were prepared based on the related literature. The interview questions were examined and reviewed according to content validity by two faculty members, one from the Special Education Department at Gazi University, and one from the Computer Education and Instructional Technology Department at Middle East Technical University. These two experts expressed a positive opinion and stated that the questions were appropriate to use. The interview question forms for each interview participant group are included as appendices to this study (see Appendix I for students, Appendix J for teachers, and Appendix K for experts).

After preparing the General Information Form, the Observation Form, the Questions for Generalization with Real Objects Form, the Interview Question forms, and other additional documents, the researcher applied to the Middle East Technical University's, Human Subjects Ethics Committee in order to seek approval for study to proceed. The Human Subject Ethics Committee approved the study to be conducted in schools (see Appendix L). Also, the various forms and documents were forwarded to the Strategy Development Department of the General Directorate of Innovation and Education Technologies at the MoNE in order to gain their approval to conduct this study within the named special education schools. The Strategy Development

Department also approved the study to be carried out in the selected special education schools (see Appendix M). After receipt of these approvals, the researcher commenced the data collection process.

Social validity is crucial in research in order to determine the usefulness of the application (treatment) procedures and evaluations, its acceptability, and its social appropriateness (Walker, Shippen, Alberto, Houchins, & Cihak, 2005). As to the purpose of determining the applicability of the Shape Finder application under development, the benefit/significance of the study and the social appropriateness of the research results and interviews were used to examine its social validity. Wolf (1978) mentioned three types of social validity as (a) social significance of the goals, (b) social appropriateness of the procedures, and (c) social importance of the effects. In this study, data on the third social validity type described by Wolf was collected by means of the interviews. In these interviews, students, teachers, and experts answered questions about their opinions on the study such as whether or not they liked using technology-based materials in the classroom, the teaching concepts applied within this application, or the appropriateness of the application to DIM etc.

Each of the interviews were conducted by the researcher after the whole process of training and evaluation sessions with the Shape Finder application had ended. Permission was sought from every interviewee prior to starting the interview. Interviews of the students lasted between five and ten minutes because their questions were mostly closed “yes/no” type questions and about their feelings due to their personal situation. However, the teachers’ and experts’ interviews lasted much longer, taking between fifteen and twenty minutes. At the beginning of the interview, it was emphasized that the answers should be expressed as clearly as possible, and that this was considered very important to the researcher. All interviews were audio recorded with the permission of the interviewees.

### 3.8. Data Analysis

Analysis of the acquired data was analyzed in order to determine whether or not any significant difference exists in the data obtained on the usage of technology-based material which is designed based on Direct Instruction Model named as the Shape Finder application. The application was designed according to the Direct Instruction Model for the teaching of the concepts of cube, cylinder, and cone shapes as 3D geometric figures to students with intellectual disabilities. The analyses were performed according to probe and baseline data, evaluation data, and generalization games data from the Shape Finder application using data stored separately for each shape and each student.

The results are shown graphically while analyzing data obtained in studies made with single-subject experimental designs, and the data are interpreted using these graphics. The use of graphics makes it easier to see the performance of the subjects in a realistic way. At the same time, it allows the researcher(s) to provide feedback to the participants in a more effective way (Tekin & Kırcaali-İftar, 2001).

In this study, graphical analysis was used to answer the first sub research question. Each student's data stored for each concept (cube, cylinder, and cone shapes) were analyzed graphically for each student individually. Follow-up data, which were collected in the 3rd, 4th, and 5th weeks after training, provided information about the sustainability of the learned concepts. The follow-up data were also graphically analyzed. The graphics were designed according to multiple probe design across behaviors. In each graph, sessions (days) were located on the *x*-axis, and the percentages of students' correct responses were located on the *y*-axis. The *x*-axis gave information about probe data, baseline data, data of the training and evaluation sessions of the Shape Finder application and maintenance data, whereas the *y*-axis gave information about the performance percentages of the students.

In the study, bar graphs were used together with multiple probe design across behaviors graphs. Bar graphs were used to examine generalization data saved in the Shape Finder application, as they summarize the performance of subjects across different phases of a research study (Kırcaali-İftar & Tekin, 1997). This study determined the percentage of total correct responses that students gave to the questions in order to measure generalizability of the concepts for different contexts such as "Put the cube shape under the table."

Furthermore, qualitative data analysis was also used to analyze the interview data. Creswell (2009) describes qualitative data analysis as an ongoing process throughout a study, involving contextual reflections about the study, asking analytical questions and writing notes. There are six steps while analyzing the data, which are (1) preparing and organizing data for analysis, (2) exploring and coding data, (3) coding to build description and themes, (4) representing and reporting qualitative findings, (5) interpreting the findings, and (6) validating the accuracy of findings (Creswell, 2013). In this study, the researcher performed interviews with three teachers of students with ID and also with six special education experts. The audio recordings of the interviews were then transcribed by the researcher as soon after the interviews as possible. All transcriptions were transferred to MS Word documents and then organized.

Then, the coding of the interview data was performed by the researcher. Coding means analyzed the raw data, dividing it into smaller, more meaningful pieces without losing sight of the relationships between them. Coding helps researchers to distinguish and aggregate the collected data (Miles & Huberman, 1994). There are different types of coding strategies. One of them is creating a new coding table based on the current study, another is using a predetermined coding table from the literature, and another is combining these two tables to create a new combined version (Creswell, 2007, 2009; Miles & Huberman, 1994). In the current study, the first strategy was used, and a coding table was created based on the data of the study. Then, the themes and subthemes were designated by the researcher (see Table 15).

### 3.9. Trustworthiness

A researcher must be certain that the findings and interpretations are valid and correct from the beginning through to the end of the study. In order to address validation issues, addressing certain questions can help the researcher such as, "*Is the account valid, and by whose standards?*" and "*How do we evaluate the quality of qualitative research?*" (Creswell, 2013, p. 243).

In addition to the number of criteria, there are several strategies that need to be considered to support trustworthiness; these strategies can be listed as triangulation, peer review, debriefing, negative case analysis, clarifying researcher bias, member checking, rich description, external audits, and intercoder agreement (Creswell, 2013). In this study, triangulation, peer debriefing, rich description, and intercoder agreement strategies were employed in order to assure the trustworthiness of the study.

### 3.9.1. Triangulation

Triangulation is one of the strategies used to strengthen the trustworthiness of a study collaboratively using multiple and different data sources or methods to support stronger evidence of themes and results of a study (Creswell, 2009, 2013; Lincoln & Guba, 1985; Miles & Huberman, 1994; Yin, 2011). In the current study, the researcher used three different data collection strategies which were the Shape Finder application, observations, and interviews.

### 3.9.2. Peer Debriefing

Another strategy employed to strengthen the trustworthiness of a study is peer debriefing. In peer debriefing, an external researcher checks the research process and asks critical questions to the main researcher in order to make the researcher self-criticize the process and to ensure their honesty (Creswell, 2009, 2013; Lincoln & Guba, 1985; Miles & Huberman, 1994; Yin, 2011). In the current study, the researcher's dissertation advisor, co-advisor, and dissertation committee maintained control over the research process. All findings and results were presented to the advisor and co-advisor throughout the process, and also to the dissertation committee every six months.

### 3.9.3. Rich Description

In rich description, researchers provide the reader with as much information as possible about the research processes so that they can easily understand each stage of the research and the results, and to ensure transferability of the research to other studies with similar characteristics (Creswell, 2013; Lincoln & Guba, 1985; Miles &

Huberman, 1994). In the current study, each step and its results have been explained in detail so as to provide rich descriptions to readers and to other researchers in order that they can easily understand the process and interpret the findings.

### 3.9.4. Intercoder Agreement

Defining codes is the biggest challenge in qualitative research. In a qualitative research, reliability often refers to the coherence of codes between different coders (Creswell, 2013). In order to obtain intercoder agreement, the definition of codes and the code assigned to a limited portion of data should be the same for every coder (Creswell, 2009, 2013; Miles & Huberman, 1994).

In the current study, the researcher checked the intercoder agreement with three separate coders. The second coder was an Assistant Professor from the Computer Education and Instructional Technology Department, who obtained B.Sc., M.Sc., and Ph.D. degrees from the same department at the Middle East Technical University, and took several courses on instructional technology, educational research, and statistics. The third coder was an Assistant Professor from the Educational Sciences Department, who obtained a B.Sc. and an integrated Ph.D. degree from the Computer Education and Instructional Technology Department at the Middle East Technical University, and also took several courses on instructional technology, educational research, and statistics. The fourth coder was an Assistant Professor in the Computer Education and Instructional Technology Department, who obtained a B.Sc. and M.Sc. degree from the same department at Gazi University, and a Ph.D. degree from the same department at the Middle East Technical University, plus took several courses on instructional technology, educational research, and statistics.

Before the commencement of the coding process, the four coders met and discussed the rationale, methodology, and data collections processes of the study. Then, each coder independently coded one teacher’s interview transcript. After all of the coders had finished their coding of the document, they met to conduct a crosscheck of their coding results. All of the coders compared the codes given in terms of their similarity and differences. They also compared the data representing each code in order to obtain a common understanding. They discussed all of the codes and data chunks in the first document so as to create a common coding table and to obtain a sense of the commonality. After discussion, a mutual coding table was created. Then, based on the created coding table, all coders independently coded a second document, and then checked each other's codes and data chunks. In this second document, all of the coders were found to have agreed. Then, the researcher continued to code the remainder of the interview transcriptions. After finishing all of the transcriptions, the coded documents were sent to the other three coders to be checked. All the coded documents were controlled and the coders agreed on the codes and data chunks for each coded document.

### 3.10. Limitations

There are always limitations to research studies, as is the nature of the task, and equally, this current study has certain limitations. The first limitation was the sampling. Purposive sampling method was used as the sampling strategy in order to determine the target group. In addition, the study was undertaken with only a low number of participant students with intellectual disabilities and their teachers. Due to the specific purpose of this study and the prerequisite characteristics of the student participants, the number of students selected was very low. Therefore, the findings of the study are valid just for this study and cannot be generalized.

The researcher was the second limitation. All data were collected, transcribed, and analyzed by the researcher, who played a key role as both a data collection instrument and data analysis tool. Different trustworthiness strategies were employed in the study, but still, all data were mainly interpreted solely by the researcher. In addition, another limitation was the honesty of the participants. It was assumed that each participant answered the questions honestly and profoundly.

The final limitation was the language. The mother tongue of each of the participants was Turkish, so each of the interviews were conducted in this language. However, the official instructional language of METU is English and likewise, the dissertation must also be written, and all results presented in the English language. Therefore, it is possible that some semantic shift in translation occurred from Turkish to English in the results part of the study.

### 3.11. Timetable of the Study

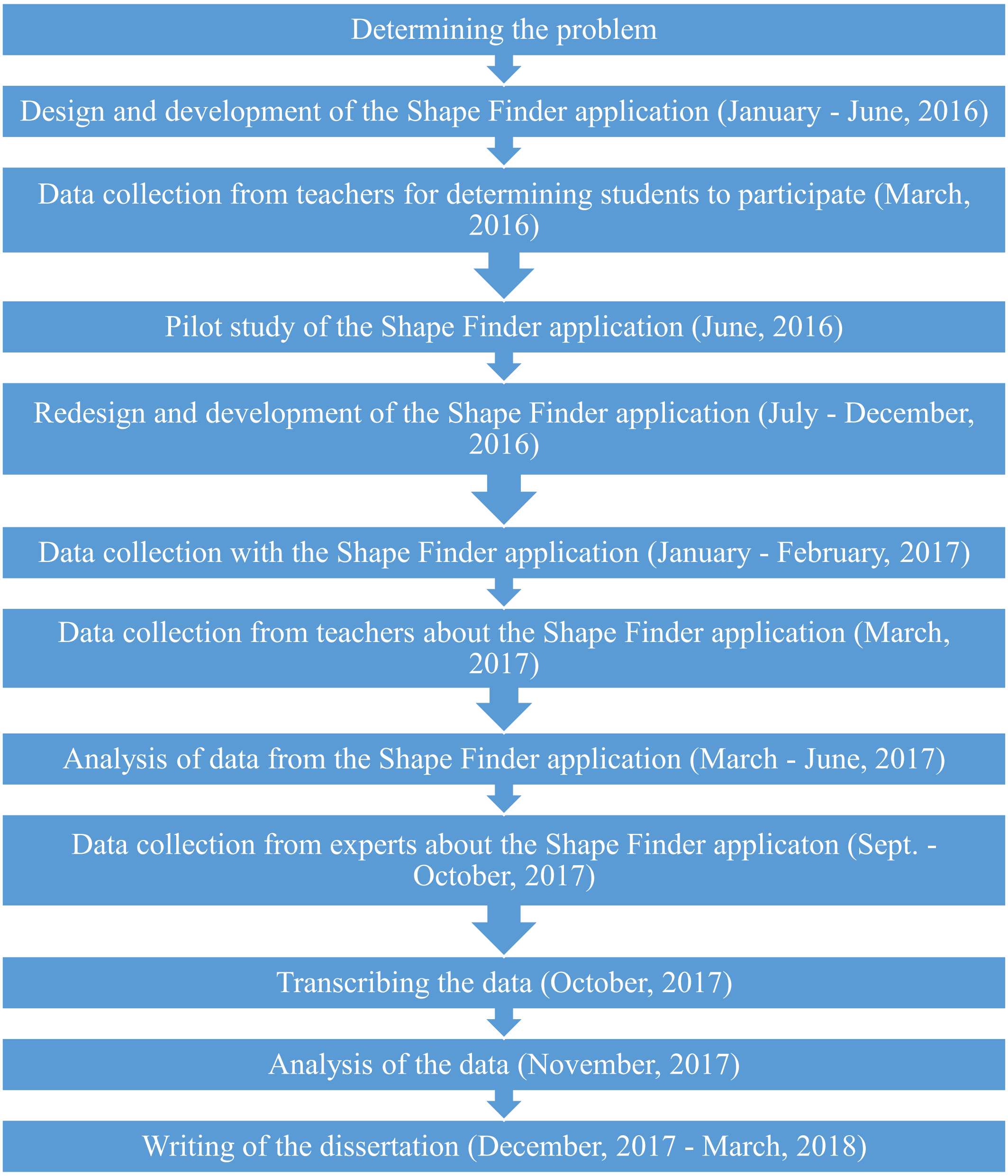


Figure 21: Timetable of the study

# CHAPTER 4

# RESULTS

In this chapter, the results of the study are presented according to the research questions of the study. Contribution of the Shape Finder application to cube, cylinder and cone shapes acquisition of students with intellectual disability, and retention rates of labeling and generalization of newly learned concepts are the topics presented. Also, opinions of participant students, teachers, and experts are presented as social validity data of the study.

## 4.1. Contribution of Shape Finder Application to Cube, Cylinder, and Cone Shapes Acquisitions of Students with ID

Contribution of Shape Finder application to cube, cylinder and cone shapes acquisition of students with intellectual disabilities was the first research question of the study. This question was elaborated in three sub questions which were explained in next topics. In addition to results, the Shape Finder application provided an opportunity to examine the duration of training and evaluation sessions and duration of generalization game sessions of all participated students with intellectual disabilities. All duration data of student participants who are Student-1 (St-1), Student-2 (St-2), Student-3 (St-3) and Student-4 (St-4) were represented in Table 3. As seen from Table 3, Student-1 has spent totally 15 minutes 32 seconds to learn the cube shapes by using Shape Finder application. For cylinder shape, Student-1 has spent totally 21 minutes 32 seconds, and also for cone shape totally 18 minutes have been spent by Student-1 on training days.

The duration data of Student-2 shows that she has spent totally 16 minutes in cube shape parts, 22 minutes 15 seconds in cylinder shapes parts and 20 minutes 40 seconds in cone shape parts while learning these shapes with Shape Finder application on training days. When the results of Student-3 was examined, it was seen that Student-3 has spent totally 15 minutes 40 seconds in cube shape parts, 15 minutes 50 seconds in cylinder shape parts and 17 minutes 15 seconds in cone shape parts in Shape Finder application on training days. Lastly, Student-4 has spent totally 11 minutes 40 seconds in cube shape parts, 13 minutes 45 seconds in cylinder shape parts and 13 minutes 35 seconds in cone shape parts in Shape Finder application on training days. According to these results it can be said that by using Shape Finder application, participated students with intellectual disabilities can learn a shape between approximately 15 and 22 minutes. Therefore, it can be said that this Shape Finder application designed based on Direct Instruction Method provides to gain a concept acquisition of students with mild intellectual disabilities in short time.

Table 3

*Durations of training and evaluation session and generalization game sessions for all students with intellectual disabilities on training days*

| *Sessions* | *St-1* | *St-2* | *St-3* | *St-4* |
|---|---|---|---|---|
| Cube 1 Training & Evaluation Session | 5m 10s | 6m | 6m | 5m |
| Cube 2 Training & Evaluation Session | 7m 22s | 6m | 5m 40s | 4m 40s |
| Cube Generalization Game Session | 3m | 4m | 4m | 2m |
| Cylinder 1 Training & Evaluation Session | 8m | 9m | 8m | 6m |
| Cylinder 2 Training & Evaluation Session | 11m22s | 9m 45s | 4m | 5m 45s |
| Cylinder Generalization Game Session | 2m 10s | 3m 30s | 3m 50s | 2m |
| Cone 1 Training & Evaluation Session | 10m | 8m | 7m | 4m |
| Cone 2 Training & Evaluation Session | 4m | 8m 50s | 3m 50s | 4m 50s |
| Cone Generalization Game Session | 4m | 3m 50s | 6m 25s | 4m 45s |

The sub questions of first research question about the contribution of Shape Finder application to cube, cylinder, and cone shapes acquisitions of students with ID are explained in next section in detail.

### 4.1.1. Contribution of Shape Finder Application to Labeling Skill of Students with ID on Cube, Cylinder, and Cone Shapes

One of the purposes of this study was to determine whether or not usage of the Shape Finder application, which was designed based on the Direct Instruction Model, contributed to the labeling skills of students with intellectual disabilities on 3D cube, cylinder, and cone geometric shapes. In order to understand the contributions of the Shape Finder application in labeling the shapes, data collected in Word document format were collected from baseline and probe sessions, and data from evaluation sessions of the Shape Finder application were analyzed separately for each student.

Figure 22 illustrates the correct response percentage for Student-1 across all sessions within the context of a multiple probe design (days) across behaviors (the learning of shapes with the application). As can be seen in Figure 22, Student-1 recorded 0% (zero percent) correct responses to each shape at the beginning of the training, according to the baseline and probe data. After the first training session with the cube on the Shape Finder application, the percentage of correct responses for Student-1 increased to 100%, and was also 100% after the second training session.

At the end of the cube shape training sessions, the baseline data for the cylinder shape and probe data of the cone shape were collected, and the results were 0% (zero percent), which indicated that Student-1 still did not have any knowledge about either the cylinder or cone shapes. After completion of both the first and second training sessions for the cylinder shape with the Shape Finder application, the percentage of correct responses had increased to 100% for both evaluation sessions.

After the cylinder shape training sessions, the cone shape baseline data were collected, and its results showed that Student-1 still did not have any knowledge about the cone shape. After the first training for the cone shape with the application, the percentage of correct responses increased to 100%, and after the second training session the percentage was maintained at 100%. These results showed that this technology-based material, designed based on DIM, had contributed to the labeling skill of Student-1 for the 3D geometric shapes of cube, cylinder, and cone. This concluded that the first research question was answered for Student-1.

Figure 22 also shows that after a break of 15 days, Student-1 still remembered the shapes and labeled each one with 100% success during the 3rd, 4th, and 5th weeks after the training had ended, as illustrated in the Maintenance part of Figure 22. This student answered every question correctly during the 3rd, 4th, and 5th weeks.

When the observation data of Student-1 is examined, in all sessions, the student opened the application own by own, fulfill the all instructions in the application, blow all balloons in reinforcement part of the application and had fun while doing it. In addition to that while using the application, the student smiled whole time and having lots of fun especially in blowing the balloons parts. The student was only interested in the application. These results support the data retrieved from the application about Student-1 completed the application as planned and gave whole focus on the application.

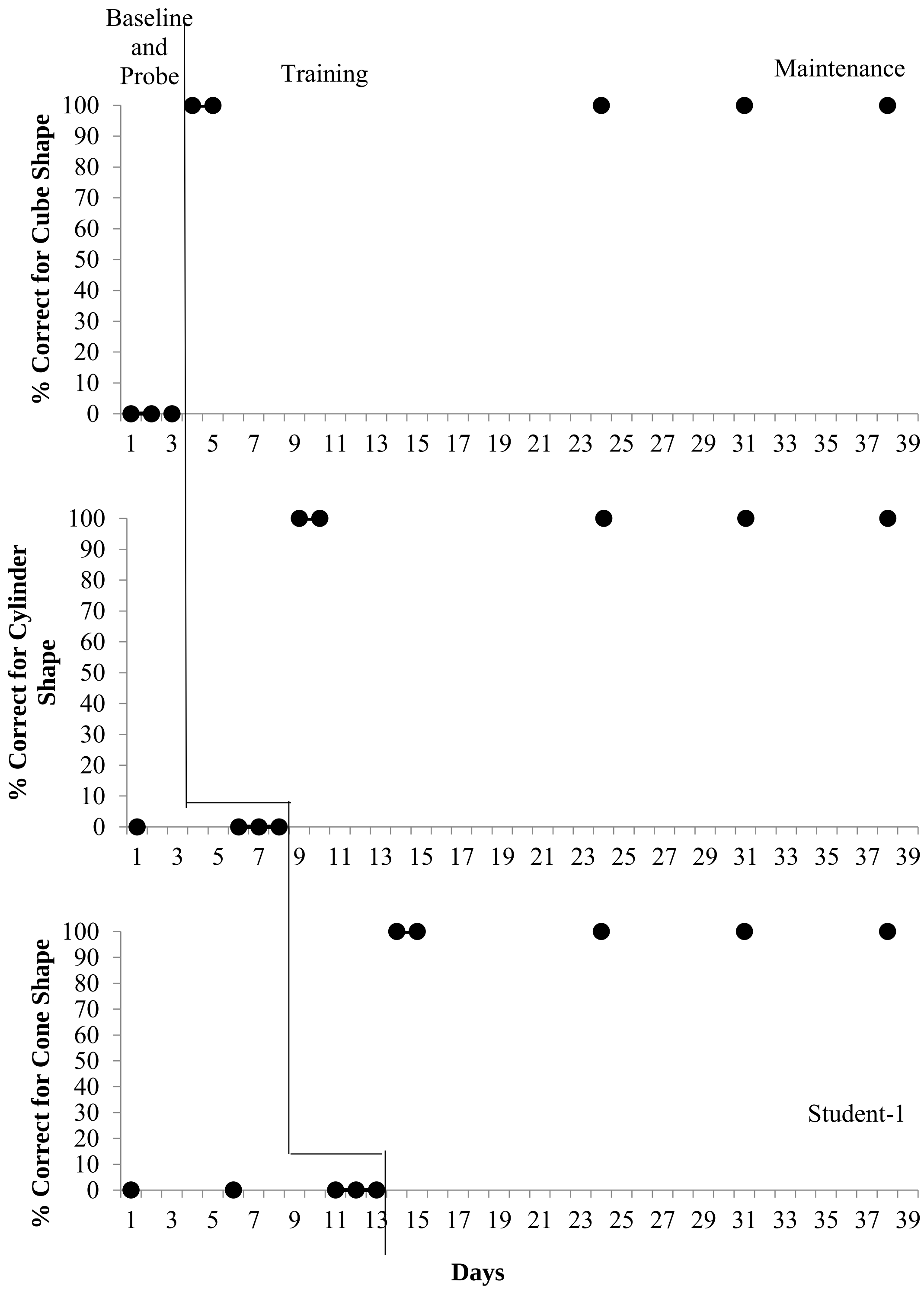


Figure 22: Graphic display of multiple probe design (days) across behaviors for Student-1.

Figure 23 illustrates the correct response percentage for Student-2 across all sessions within the context of a multiple probe design (days) across behaviors (the learning of shapes with the application). As can be seen in Figure 23, Student-2 recorded 0% (zero percent) correct responses on each shape at the beginning of the training, according to the baseline and probe data. After the first training session with the cube on the Shape Finder application, the percentage of correct responses for Student-2 increased to 100%, and was also 100% after the second training session.

At the end of cube shape training sessions, the baseline data for the cylinder shape and probe data of the cone shape were collected, and the results were 0% (zero percent), which indicated that Student-2 still did not have any knowledge about either the cylinder or cone shapes. After completion of the first training session for the cylinder shape, the percentage of correct responses had increased to above 60%. However, after the second training session for the cylinder shape, the percentage of correct responses increased to 100% for the cylinder shape.

After the cylinder shape training sessions, the cone shape baseline data were collected, and its results showed that Student-2 still did not have any knowledge about the cone shape. After the first training for the cone shape with the application, percentage of correct responses increased to 100%, and after the second training session the percentage was maintained at 100%. These results showed that this technology-based material, designed based on DIM, had contributed to the labeling skill of Student-2 for the 3D geometric shapes of cube, cylinder, and cone. This concluded that the first research question was answered for Student-2.

Figure 23 also shows that after giving a break of 15 days, Student-2 still remembered the shapes and labeled each one with 100% success during the 3rd, 4th, and 5th weeks after the training had ended, as illustrated in the Maintenance part of Figure 23. This student answered every question correctly during the 3rd, 4th, and 5th weeks.

The observation data of Student-2 showed that, in all sessions, the student opened the application own by own, fulfill the all instructions in the application, blow all balloons in reinforcement part of the application and had fun while doing it. In addition to that while using the application, the student smiled whole time and having lots of fun especially while blowing the balloons. The student was only interested in the application. However, while using the application, it was observed that the student had trouble in labeling session, but with the help of many repetitions, that was provided by the adding more questions if the students gives wrong answer feature of the application, Student-2 completed whole steps in the application and learned the three shapes. This situation helped the shapes acquisition of the Student-2. These results support the data retrieved from the application about Student-2 completed the application as planned and gave whole focus on the application.

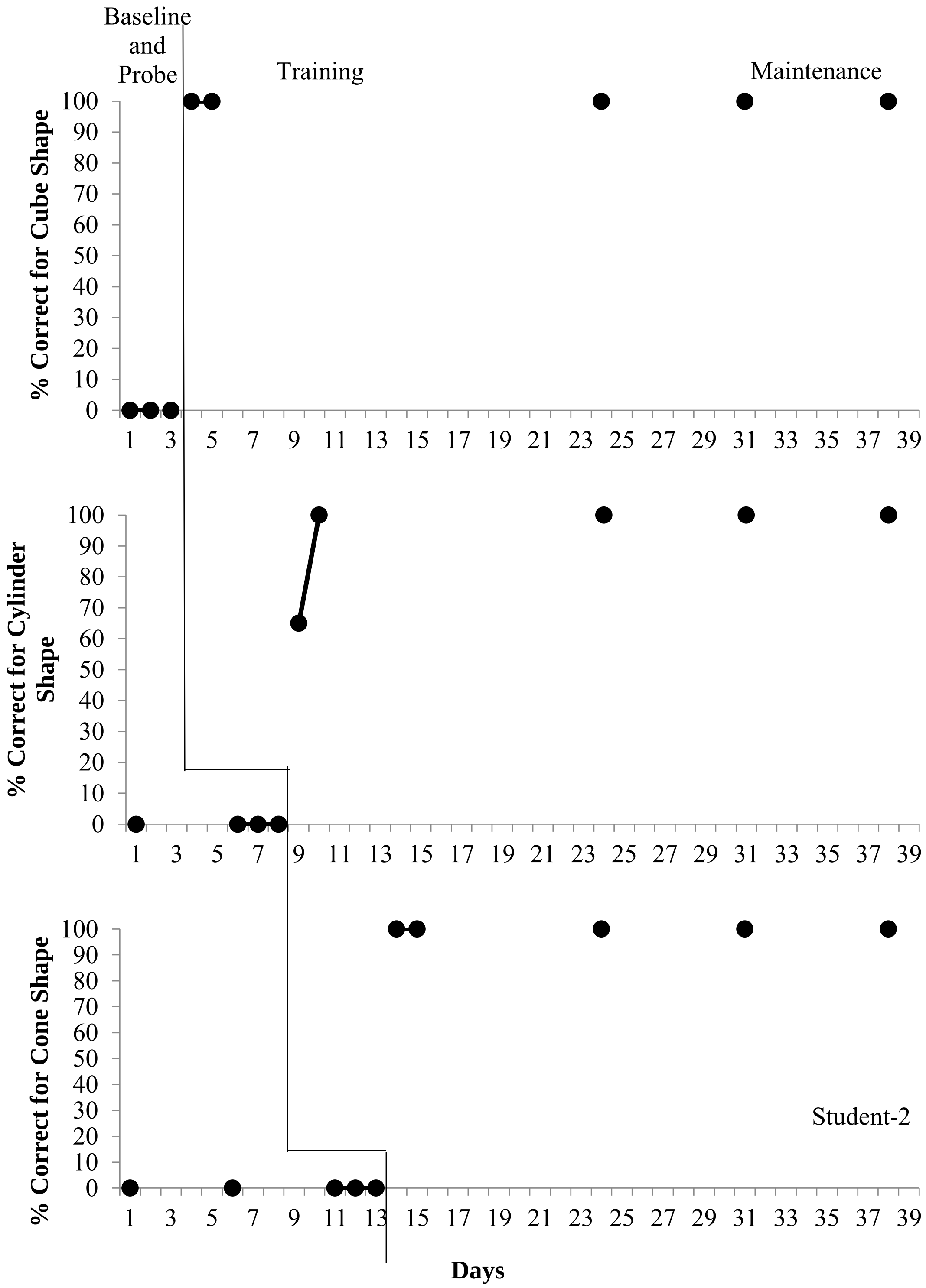


Figure 23: Graphic display of multiple probe design (days) across behaviors for Student-2

Figure 24 illustrates the correct response percentage for Student-3 across all sessions within the context of a multiple probe design (days) across behaviors (the learning of shapes with the application). As can be seen in Figure 24, Student-3 recorded 0% (zero percent) of correct responses to each shape at the beginning of the training, according to the baseline and probe data. After the first training session with the cube on the Shape Finder application, the percentage of correct responses for Student-3 increased to 100%, and was also 100% after the second training session.

At the end of the cube shape training sessions, the baseline data for the cylinder shape and probe data of the cone shape were collected, and the results were 0% (zero percent), which indicated that Student-3 still did not have any knowledge about either the cylinder or cone shapes. After completion of both the first and second training sessions for the cylinder shape with the Shape Finder application, the percentage of correct responses had increased to 100% for both evaluation sessions.

After the cylinder shape training sessions, the cone shape baseline data were collected, and its results showed that Student-3 still did not have any knowledge about the cone shape. After the first training for the cone shape with the application, the percentage of correct responses increased to 100%, and after the second training session the percentage was maintained at 100%. These results showed that this technology-based material, designed based on DIM, had contributed to the labeling skill of Student-3 for the 3D geometric shapes of cube, cylinder, and cone. This concluded that the first research question was answered for Student-3.

Figure 24 also shows that after a break of 15 days, Student-3 still remembered the shapes and labeled each one with 100% success during the 3rd, 4th, and 5th weeks after the training had ended, as illustrated in the Maintenance part of Figure 24. This student answered every question correctly during the 3rd, 4th, and 5th weeks.

When the observation data of Student-3 is examined, in all sessions, the student opened the application own by own, fulfill the all instructions in the application, blow all balloons in reinforcement part of the application. In addition to that while using the application, the student smiled whole time and having lots of fun especially while blowing the balloons. These results support the data retrieved from the application about Student-3 completed the application as planned and gave whole focus on the application.

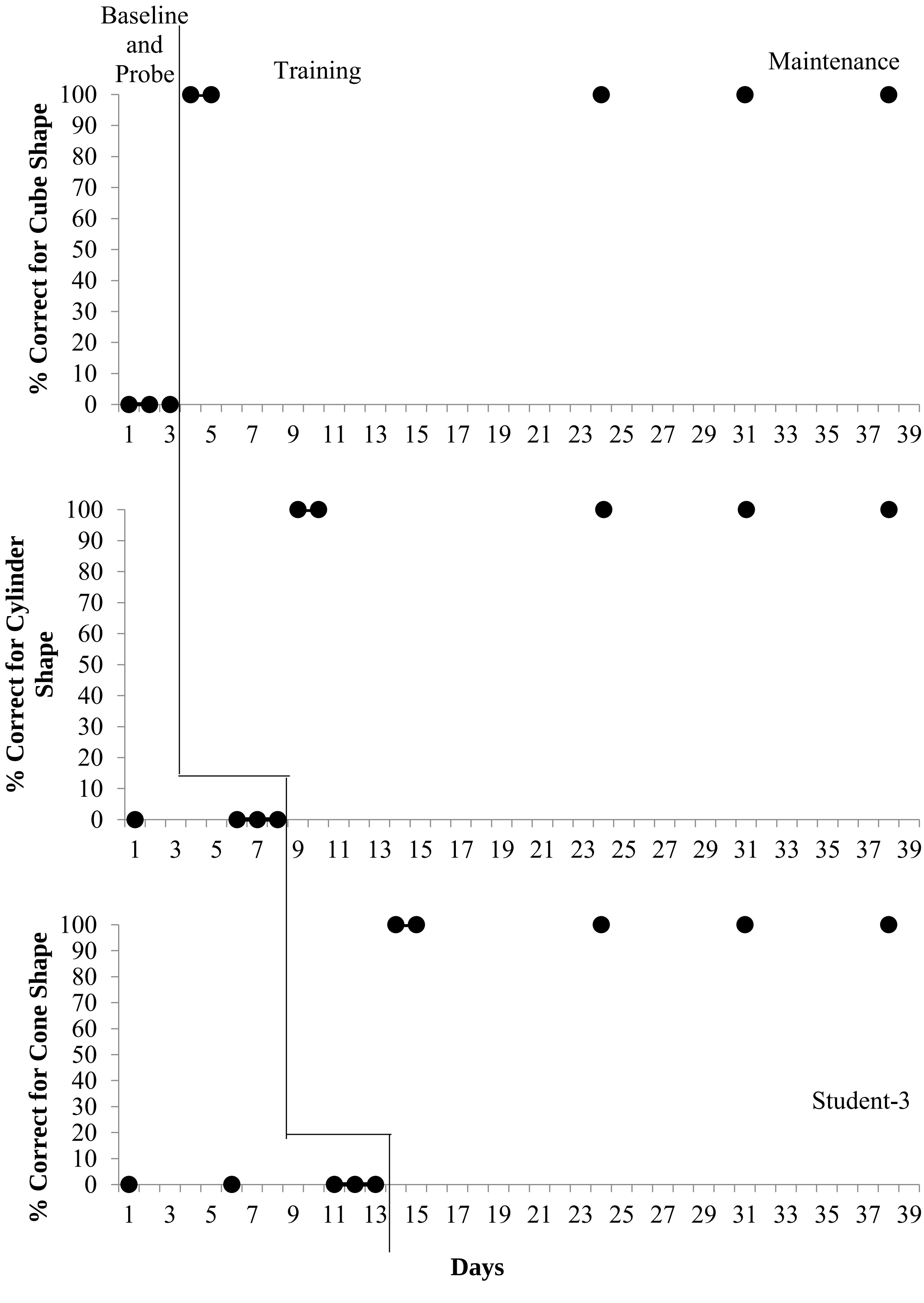


Figure 24: Graphic display of multiple probe design (days) across behaviors for Student-3.

The last student participant's results are shown in Figure 25. This illustrates the correct response percentage for Student-4 across all sessions within the context of a multiple probe design (days) across behaviors (the learning of shapes with the application). As can be seen in Figure 25, Student-4 also recorded 0% (zero percent) of correct responses to each shape at the beginning of the training, according to the baseline and probe data. After the first training session with the cube on the Shape Finder application, the percentage of correct responses for Student-4 also increased to 100%, and was also 100% after the second training session.

At the end of the cube shape training sessions, the baseline data for the cylinder shape and probe data of the cone shape were collected, and the results were 0% (zero percent), which indicated that Student-4 still did not have any knowledge about either the cylinder or cone shapes. After completion of both the first and second training sessions for the cylinder shape with the Shape Finder application, the percentage of correct responses had increased to 100% for both evaluation sessions.

After the cylinder shape training sessions, the cone shape baseline data were collected, and its results showed that Student-4 still did not have any knowledge about the cone shape. After the first training for the cone shape with the application, the percentage of correct responses increased to 100%, and after the second training session the percentage was maintained at 100%. These results showed that this technology-based material, designed based on DIM, had contributed to the labeling skill of Student-4 for the 3D geometric shapes of cube, cylinder, and cone. This concluded that the first research question was answered for Student-4.

Figure 25 also shows that after a break of 15 days, Student-4 still remembered the shapes and labeled each one with 100% success during the 3rd, 4th, and 5th weeks after the training had ended, as illustrated in the Maintenance part of Figure 25. This student answered every question correctly during the 3rd, 4th, and 5th weeks.

The observation data of Student-4 shows that, in all sessions, the student opened the application own by own, fulfill the all instructions in the application, blow all balloons in reinforcement part of the application and had fun while doing it. In addition to that while using the application, the student smiled whole time and having lots of fun especially in blowing the balloons parts. This student was the first completer while playing the Shape Finder application in all sessions. These results support the data retrieved from the application about Student-4 completed the application as planned and gave whole focus on the application.

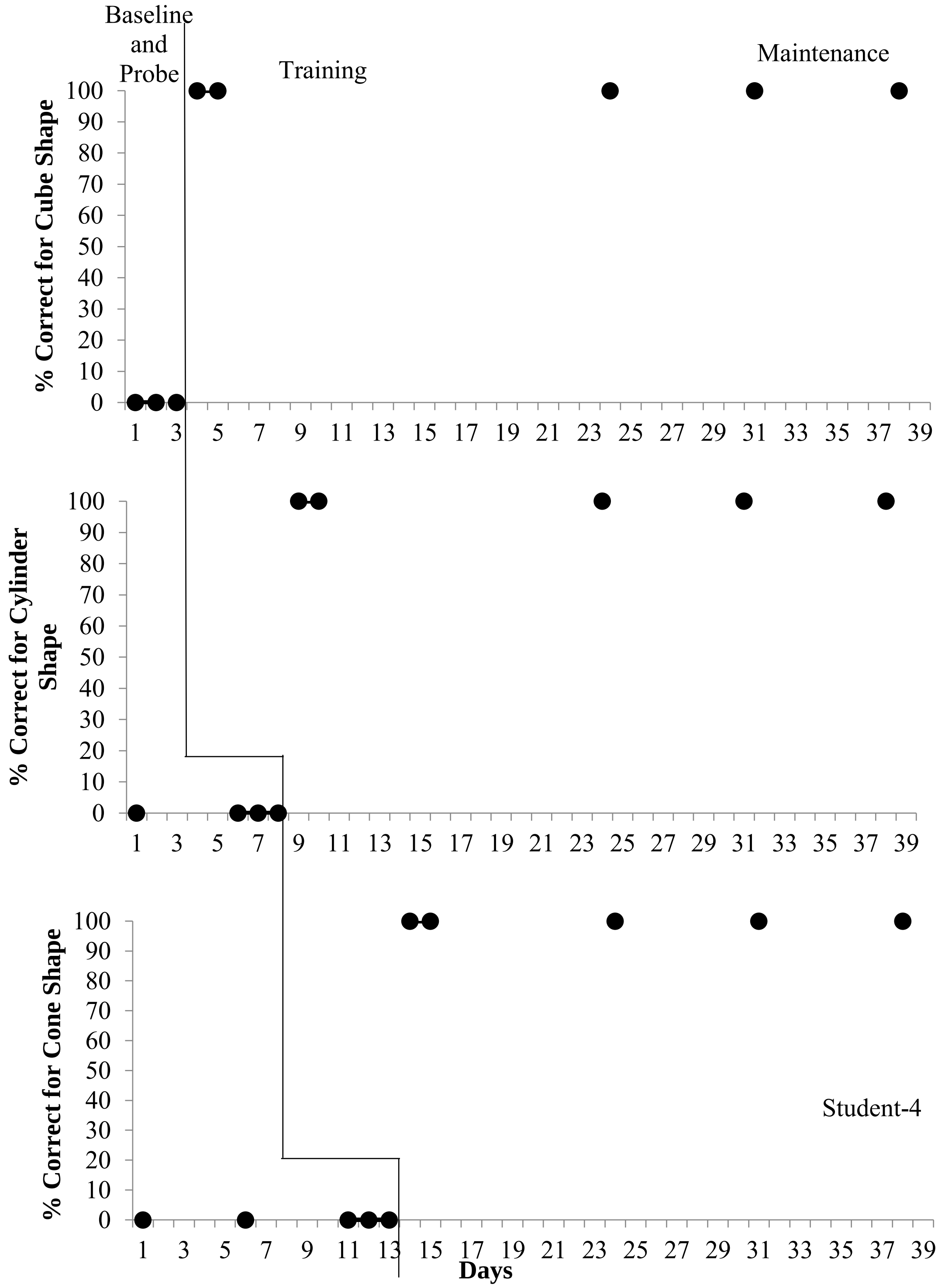


Figure 25: Graphic display of multiple probe design (days) across behaviors for Student-4

#### 4.1.2. Contribution of Shape Finder Application to the Generalization of Newly Learned Shapes to Different Context by Students with ID

In this study, students' learning corresponded to the actualization of their labeling and generalization skills. Therefore, the second sub-question was about the generalization of cube, cylinder, and cone shapes. In order to understand the contributions of the Shape Finder application to generalization of these newly learned shapes, data stored in the games on the Shape Finder application were examined separately for each participant student.

In these games, especially for the cone and cylinder games, the students were supposed to follow whatever the application voice said such as putting the cube shape under the table on the tablet computer screen. In the cone game, the students were tasked with distinguishing and matching all newly learned shapes and previously known shapes like squares, circles, and triangles with their shape names. Each question contained three shapes and three corresponding names that required matching. There were 10 questions for each of the three games; with one game for each shape type of cube, cylinder, and cone.

Student-1's data results for the games are shown in Table 4 for the cube, cylinder, and cone shapes. The data were collected on training days for each of the corresponding shapes. All results were recorded as seconds taken to correctly perform the shape and name matches. Table 4 shows that Student-1 was able to generalize the cube, cylinder, and cone shapes into different situations by correctly placing the shape near the red books on the tablet computer screen; and then correctly matching each shape to its name. This result means that the Shape Finder application had contributed to the generalization of the newly learned shapes in different contexts for Student-1. This student spent approximately the same time on each of the games. Student-1 also observed while playing the generalization game parts and according to observation results, the student had fun while playing the games, gave whole attention to the application to understand which place the voiceover will say.

Table 4
*Generalization Game Results for Student-1 on Training Days*

| *Games* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game | 3 | 3 | 2 | 2 | 1 | 2 | 2 | 2 | 2 | 8 |
| Cylinder game | 3 | 2 | 2 | 2 | 1 | 2 | 2 | 2 | 3 | 2 |
| Cone game | 6 | 6 | 5 | 5 | 5 | 4 | 5 | 9 | 5 | 8 |

Student-2's data results for the games are shown in Table 5 for the cube, cylinder, and cone shapes. The data were collected on training days for each of the corresponding shapes. All results were recorded as seconds taken to correctly perform the shape and name matches. Table 5 shows that Student-2 was able to generalize the cube, cylinder, and cone shapes into different situations by correctly placing the shape near the red books on the tablet computer screen; and then correctly matching shape to its name. This result means that the Shape Finder application had contributed to the generalization of the newly learned shapes in different contexts by Student-2. This student spent approximately the same time on the cube and cylinder games, but spent more time on the cone game. Student-2 also observed while playing the generalization game parts. According to observation results, the student had fun while playing the games and smiling whole time, gave whole attention to the application. In cone game part, the student was very careful to place the shape into right shelves, so she spent more time according to other games.

Table 5
*Generalization Game Results for Student-2 on Training Days*

| *Games* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game | 6 | 2 | 1 | 6 | 2 | 2 | 5 | 2 | 2 | 1 |
| Cylinder game | 4 | 4 | 8 | 3 | 4 | 6 | 6 | 5 | 6 | 3 |
| Cone game | 8 | 15 | 14 | 17 | 12 | 11 | 12 | 13 | 14 | 14 |

Student-3's data results for the games are shown in Table 6 for the cube, cylinder, and cone shapes. The data were collected on training days for each of the corresponding shapes. All results were recorded as seconds taken to correctly perform the shape and name matches. Table 6 shows that Student-3 was able to generalize the cube, cylinder, and cone shapes into different situations by correctly placing the shape near the red books on the tablet computer screen; and then correctly matching each shapes to its name. This result means that the Shape Finder application had contributed to the generalization of the newly learned shapes in different contexts for Student-3. This student spent approximately the same time on the cube and cylinder games, but spent more time on the cone game. Student-3 also observed while playing the generalization game parts and according to observation results, the student had fun while playing the games, and also in every session, she wanted to play the games one more time. She did not have any trouble while playing the games. She completed whole games willingly.

Table 6
*Generalization Game Results for Student-3 on Training Days*

| *Games* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game | 7 | 7 | 6 | 4 | 1 | 6 | 2 | 2 | 2 | 2 |
| Cylinder game | 5 | 4 | 6 | 5 | 7 | 4 | 9 | 5 | 5 | 4 |
| Cone game | 16 | 12 | 8 | 8 | 13 | 8 | 9 | 8 | 16 | 16 |

Student-4's data results for the games are shown in Table 7 for the cube, cylinder, and cone shapes. The data were collected on training days for each of the corresponding shapes. All results were recorded as seconds taken to correctly perform the shape and name matches. Table 7 showed that Student-4 was able to generalize the cube, cylinder and cone shapes into different situations by correctly placing the shape near the red books on the tablet computer screen; and then correctly matching each shape to its name. This result means that the Shape Finder application had contributed to the generalization of the newly learned shapes in different contexts for Student-4. This student spent similar amounts of time on the cube and cylinder games but spent a little more time on the cone game. Student-4 also observed while playing the generalization game parts. According to observation results, the student had fun while playing the games, and gave whole attention to the games. She completed whole games willingly and with the desire to be first finisher.

Table 7
*Generalization Game Results for Student-4 on Training Days*

| *Games* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game | 2 | 2 | 3 | 2 | 1 | 2 | 2 | 2 | 2 | 2 |
| Cylinder game | 9 | 3 | 5 | 3 | 3 | 4 | 4 | 3 | 7 | 1 |
| Cone game | 9 | 15 | 5 | 6 | 7 | 7 | 5 | 6 | 6 | 8 |

### 4.1.3. Contribution of Shape Finder Application to the Generalization of Newly Learned Shapes to Different Contexts by Using Real Objects by Students with ID

In order to examine the generalizability of newly learned shapes to real objects of cube, cylinder, and cone shapes, each shape had 10 questions for a total of 30 questions asked to students with ID, as detailed in the Data Collection section (see Appendix E).

The data results of the Checklist of Real Objects' Questions are shown in Figure 26 for Student-1. The skill achievement percentages in the pre-tests were marked as 0% (zero percent) as Student-1 could not perform any of the steps of the target skills during the preliminary test session of Generalization with Real Objects. After the training sessions, Student-1 was able to recognize and distinguish the real objects of the cube, cylinder, and cone shapes, and achieved to generalize 100% of the skills to different situations with real objects. In other words, the Shape Finder application had contributed to generalization of the cube, cylinder, and cone shapes for Student-1, and was able to generalize the shapes into real-world objects. As can be seen in Figure 26, Student-1 was able to perform 100% success in the post-test session compared to 0% in the pre-test.

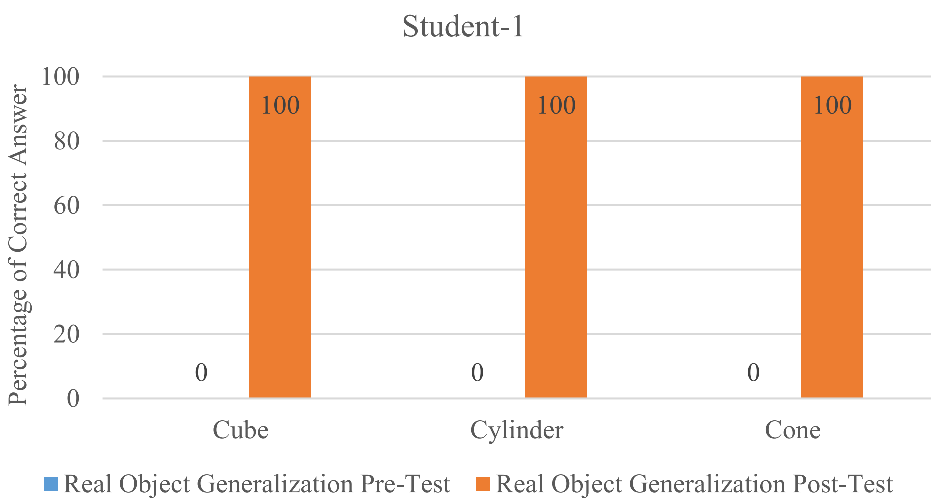


Figure 26: Graphic display of Generalization with Real Objects of Cube, Cylinder, and Cone Shapes for Student-1

The data results of the Checklist of Real Objects' Questions are shown in Figure 27 for Student-2. The skill achievement percentages in the pre-tests were marked as 0% (zero percent) as Student-2 could not perform any of the steps of the target skills during the preliminary test session of Generalization with Real Objects. After the training sessions, Student-2 was able to recognize and distinguish the real objects of the cube, cylinder, and cone shapes, and achieved to generalize 100% of the skills to different situations with different materials. In other words, the Shape Finder application had contributed to generalization of the cube, cylinder, and cone shapes for Student-2, and was able to generalize the shapes into the real-world objects. As can be seen in Figure 27, Student-2 was able to perform 100% success in the post-test session compared to 0% in the pre-test.

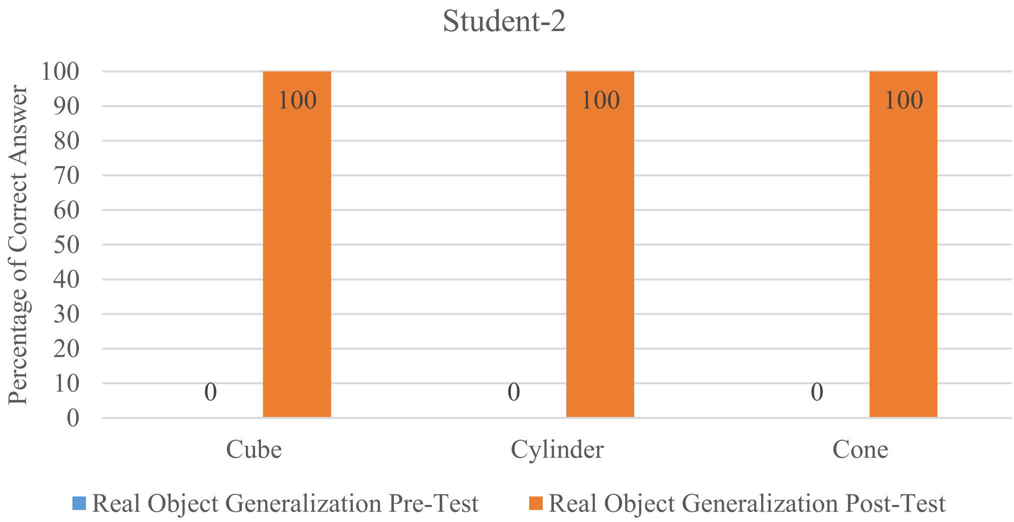


Figure 27: Graphic display of Generalization with Real Objects of Cube, Cylinder and Cone Shapes for Student-2

The data results of the Checklist of Real Objects' Questions are shown in Figure 28 for Student-3. The skill achievement percentages in the pre-tests were marked as 0% (zero percent) as Student-3 could not perform any of the steps of the target skills during the preliminary test session of Generalization with Real Objects. After the training sessions, Student-3 was able to recognize and distinguish the real objects of the cube, cylinder, and cone shapes, and achieved to generalize 100% of the skills to different situations with different materials. In other words, the Shape Finder application had contributed to generalization of the cube, cylinder, and cone shapes for Student-3, and was able to generalize the shapes into real-world objects. As can be seen in Figure 28, Student-3 was able to perform 100% success in the post-test session compared to 0% in the pre-test.

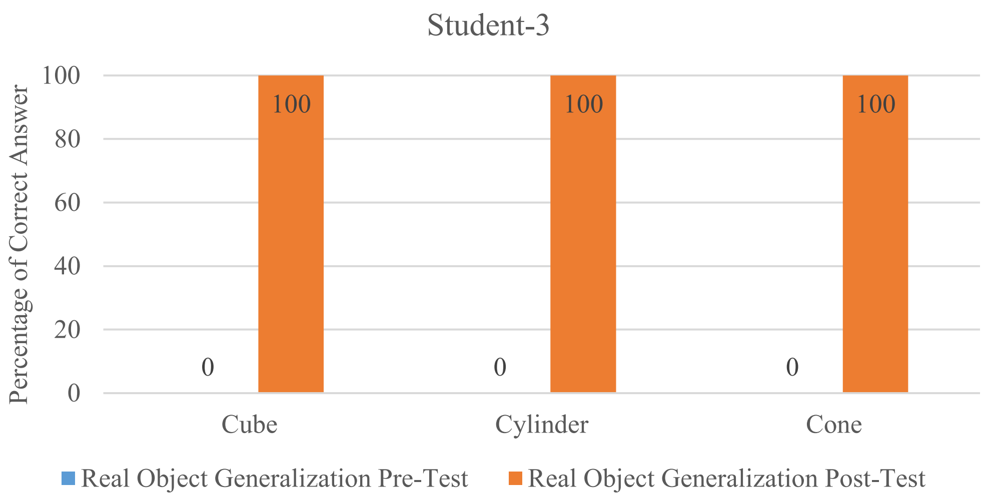


Figure 28: Graphic display of Generalization with Real Objects of Cube, Cylinder and Cone Shapes for Student-3

Lastly, the data results of the Checklist of Real Objects' Questions are shown in Figure 29 for Student-4. The skill achievement percentages in the pre-tests were marked as 0% (zero percent) as Student-4 could not perform any of the steps of the target skills during the preliminary test session of Generalization with Real Objects. After the training sessions, Student-4 was able to recognize and distinguish the real objects of the cube, cylinder, and cone shapes, and achieved to generalize 100% of the skills to different situations with different materials. In other words, the Shape Finder application had contributed to generalization of the cube, cylinder, and cone shapes for Student-4, and was able to generalize the shapes into real-world objects. As can be seen in Figure 29, Student-4 was able to perform 100% success in the post-test session compared to 0% in the pre-test.

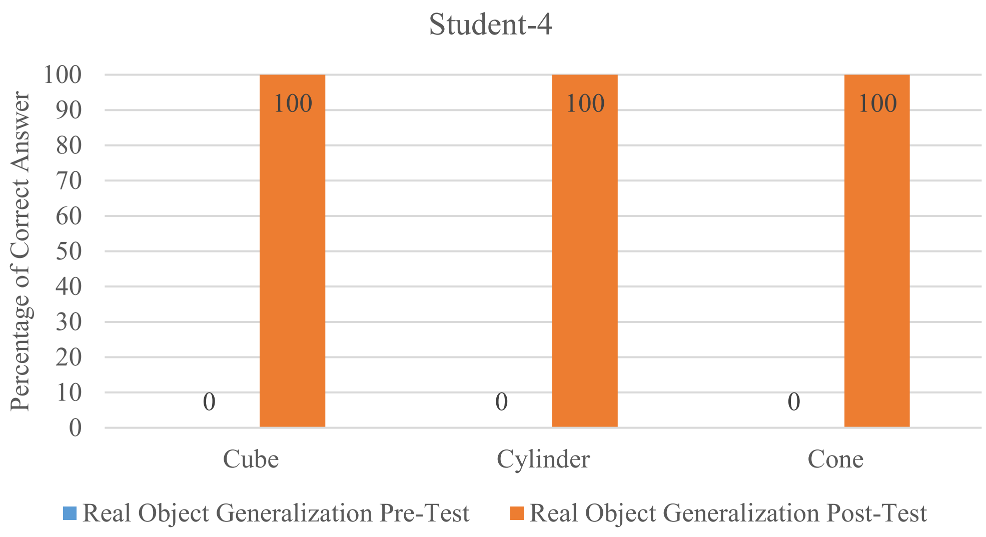


Figure 29: Graphic display of Generalization with Real Objects of Cube, Cylinder and Cone Shapes for Student-4

### 4.2. Retention Rate of Students' Labeling Skills of Newly Learned Shapes after Training was Completed

One of the main purposes of the study was to investigate the contribution of the Shape Finder application to the retention rate of labeling skills of students with ID on newly learned shapes in the weeks after the training had been completed. In other words, the study tried to examine whether or not the students remembered and were able to write the names of the shapes that they had learned with the Shape Finder application. In order to test this, previously prepared MS Word documents were used that contained 10 pictures of each shape type, therefore a total of 30 pictures were shown to the students after three, four and five weeks had elapsed since the training. It was expected that the student would be able to write the correct names of the shapes near the relevant pictures.

Table 8 shows the retention rates of labeling skills for Student-1. These results were also mentioned in the Maintenance part of Figure 22. After the training sessions had been completed, Student-1 was able to write 100% of the shapes' names correctly. This indicates that Student-1 remembered all of the shapes and their corresponding names in the 3rd, 4th, and 5th weeks after the training sessions, and had the ability to label each shape. It can therefore be said that the Shape Finder application had contributed to the labeling skills of Student-1 for the cone, cylinder, and cube shapes.

Table 8
*Retention Rates of Labeling Skill of Student-1*

| *Shapes* | *Week 3* | *Week 4* | *Week 5* |
|---|---|---|---|
| Cube | 100% | 100% | 100% |
| Cylinder | 100% | 100% | 100% |
| Cone | 100% | 100% | 100% |

Table 9 shows the retention rates of labeling skills for Student-2. These results were also mentioned in the Maintenance part of Figure 23. After the training sessions had been completed, Student-2 was able to write 100% of the shapes' names correctly. This indicates that Student-2 remembered all of the shapes and their corresponding names in the 3rd, 4th, and 5th weeks after the training sessions, and had the ability to label each shape. It can therefore be said that the Shape Finder application had contributed to the labeling skills of Student-2 for the cone, cylinder, and cube shapes.

Table 9
*Retention Rates of Labeling Skill of Student-2*

| *Shapes* | *Week 3* | *Week 4* | *Week 5* |
|---|---|---|---|
| Cube | 100% | 100% | 100% |
| Cylinder | 100% | 100% | 100% |
| Cone | 100% | 100% | 100% |

Table 10 shows the retention rates of labeling skills for Student-3. These results were also mentioned in the Maintenance part of Figure 24. After the training sessions had been completed, Student-3 was able to write 100% of the shapes' names correctly. This indicates that Student-3 remembered all of the shapes and their corresponding names in the 3rd, 4th, and 5th weeks after the training sessions; and had the ability to label each shape. It can therefore be said that the Shape Finder application had contributed to the labeling skills of Student-3 for the cone, cylinder, and cube shapes.

Table 10
*Retention Rates of Labeling Skill of Student-3*

| *Shapes* | *Week 3* | *Week 4* | *Week 5* |
|---|---|---|---|
| Cube | 100% | 100% | 100% |
| Cylinder | 100% | 100% | 100% |
| Cone | 100% | 100% | 100% |

Lastly, Table 11 shows the retention rates of labeling skills for Student-4. These results were also mentioned in the Maintenance part of Figure 25. After the training sessions had been completed, Student-4 was able to write 100% of the shapes' names correctly. This indicates that Student-4 remembered all of the shapes and their corresponding names in the 3rd, 4th, and 5th weeks after the training sessions, and had the ability to label each shape. It can therefore be said that the Shape Finder application had contributed to the labeling skill of Student-4 for the cone, cylinder, and cube shapes.

Table 11
*Retention Rates of Labeling Skill of Student-4*

| *Shapes* | *Week 3* | *Week 4* | *Week 5* |
|---|---|---|---|
| Cube | 100% | 100% | 100% |
| Cylinder | 100% | 100% | 100% |
| Cone | 100% | 100% | 100% |

### 4.3. Retention Rate of Students in Generalization of Newly Learned Shapes to Different Contexts After Training was Completed

In order to answer the third research question, the generalization games of the Shape Finder application were played by students with ID in the 3rd, 4th, and 5th weeks after the training sessions had completed. Results of each game were stored in the application. In the games, students were tasked with following the application voiceover instructions such as putting the cube shape under the table on the tablet computer screen, and then matching shapes with their corresponding names. In the games, there were 10 questions for each shape.

Student-1's data results for the generalization games are shown for the cube, cylinder, and cone shapes in Table 12. This shows that Student-1 was able to generalize each of the cube, cylinder, and cone shapes into different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed. Moreover, Table 12 shows that the results for the 3rd, 4th, and 5th weeks' post-training were approximately the same for each shape. Therefore, it can be said that the Shape Finder application had contributed to the generalization of newly learned shapes in different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed by Student-1.

Table 12
*Retention Rates of Student-1 in Generalization of Newly Learned Shapes (seconds)*

| *Session* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game, Week 3 | 2 | 1 | 2 | 1 | 1 | 2 | 1 | 1 | 1 | 1 |
| Cube game, Week 4 | 3 | 1 | 1 | 2 | 1 | 2 | 2 | 1 | 3 | 2 |
| Cube game, Week 5 | 1 | 2 | 1 | 2 | 2 | 2 | 2 | 2 | 2 | 2 |
| Cylinder game, Week 3 | 4 | 4 | 2 | 2 | 4 | 2 | 2 | 2 | 2 | 3 |
| Cylinder game, Week 4 | 3 | 2 | 1 | 3 | 2 | 2 | 3 | 2 | 2 | 2 |
| Cylinder game, Week 5 | 4 | 4 | 3 | 3 | 4 | 3 | 3 | 2 | 2 | 2 |
| Cone game, Week 3 | 11 | 5 | 5 | 11 | 4 | 4 | 4 | 4 | 5 | 5 |
| Cone game, Week 4 | 12 | 5 | 6 | 9 | 4 | 4 | 14 | 6 | 9 | 4 |
| Cone game, Week 5 | 7 | 4 | 4 | 4 | 4 | 5 | 5 | 5 | 4 | 4 |

Student-2's data results for the generalization games are shown for the cube, cylinder, and cone shapes in Table 13. This shows that Student-2 was able to generalize each of the cube, cylinder, and cone shapes into different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed. Moreover, Table 13 shows that the results for the 3rd, 4th, and 5th weeks' post-training were approximately the same for each shape. Therefore, it can be said that the Shape Finder application had contributed to the generalization of newly learned shapes in different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed by Student-2.

Table 13
*Retention Rates of Student-2 in Generalization of Newly Learned Shapes (seconds)*

| *Session* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game, Week 3 | 3 | 2 | 2 | 6 | 8 | 5 | 5 | 7 | 4 | 2 |
| Cube game, Week 4 | 3 | 3 | 2 | 3 | 3 | 2 | 7 | 2 | 4 | 5 |
| Cube game, Week 5 | 3 | 2 | 2 | 3 | 2 | 2 | 4 | 1 | 1 | 5 |
| Cylinder game, Week 3 | 3 | 7 | 4 | 4 | 8 | 8 | 3 | 5 | 4 | 6 |
| Cylinder game, Week 4 | 9 | 5 | 3 | 6 | 4 | 8 | 4 | 3 | 3 | 2 |
| Cylinder game, Week 5 | 4 | 9 | 5 | 3 | 2 | 6 | 2 | 3 | 2 | 2 |
| Cone game, Week 3 | 13 | 12 | 16 | 13 | 13 | 12 | 10 | 13 | 15 | 9 |
| Cone game, Week 4 | 9 | 13 | 11 | 14 | 10 | 11 | 11 | 12 | 13 | 12 |
| Cone game, Week 5 | 11 | 16 | 9 | 15 | 9 | 12 | 12 | 10 | 15 | 14 |

Student-3's data results for the generalization games are shown for the cube, cylinder, and cone shapes in Table 14. This shows that Student-3 was able to generalize each of the cube, cylinder, and cone shapes into different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed. Moreover, Table 14 shows that the results for the 3rd, 4th, and 5th weeks' post-training were approximately the same for each shape. Therefore, it can be said that the Shape Finder application had contributed to the generalization of newly learned shapes in different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed by Student-3.

Table 14

*Retention Rates of Student-3 in Generalization of Newly Learned Shapes (seconds)*

| *Sessions* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game, Week 3 | 3 | 3 | 4 | 2 | 2 | 7 | 3 | 3 | 2 | 3 |
| Cube game, Week 4 | 4 | 4 | 2 | 3 | 2 | 3 | 4 | 2 | 5 | 3 |
| Cube game, Week 5 | 8 | 8 | 10 | 10 | 7 | 5 | 7 | 6 | 7 | 3 |
| Cylinder game, Week 3 | 3 | 3 | 4 | 3 | 6 | 3 | 7 | 8 | 5 | 8 |
| Cylinder game, Week 4 | 3 | 7 | 6 | 3 | 3 | 3 | 3 | 3 | 5 | 9 |
| Cylinder game, Week 5 | 5 | 6 | 6 | 9 | 3 | 10 | 7 | 5 | 2 | 3 |
| Cone game, Week 3 | 13 | 9 | 10 | 9 | 19 | 11 | 18 | 10 | 9 | 13 |
| Cone game, Week 4 | 9 | 10 | 8 | 9 | 11 | 8 | 7 | 8 | 8 | 8 |
| Cone game, Week 5 | 8 | 10 | 12 | 9 | 11 | 18 | 7 | 13 | 7 | 8 |

Finally, Student-4's data results for the generalization games are shown for the cube, cylinder, and cone shapes in Table 15. This shows that Student-4 was able to generalize each of the cube, cylinder, and cone shapes into different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed. Moreover, Table 15 shows that the results for the 3rd, 4th, and 5th weeks' post-training were approximately the same for each shape. Therefore, it can be said that the Shape Finder application had contributed to the generalization of newly learned shapes in different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed by Student-4.

Table 15
*Retention Rates of Student-4 in Generalization of Newly Learned Shapes (seconds)*

| *Sessions* | *Q1* | *Q2* | *Q3* | *Q4* | *Q5* | *Q6* | *Q7* | *Q8* | *Q9* | *Q10* |
|---|---|---|---|---|---|---|---|---|---|---|
| Cube game, Week 3 | 2 | 7 | 3 | 5 | 2 | 4 | 2 | 1 | 1 | 3 |
| Cube game, Week 4 | 3 | 2 | 3 | 5 | 4 | 3 | 2 | 1 | 2 | 2 |
| Cube game, Week 5 | 3 | 5 | 6 | 3 | 3 | 9 | 2 | 2 | 7 | 7 |
| Cylinder game, Week 3 | 2 | 2 | 3 | 2 | 6 | 2 | 2 | 10 | 3 | 4 |
| Cylinder game, Week 4 | 6 | 2 | 2 | 4 | 5 | 2 | 2 | 3 | 2 | 6 |
| Cylinder game, Week 5 | 4 | 2 | 4 | 2 | 1 | 4 | 7 | 6 | 3 | 9 |
| Cone game, Week 3 | 7 | 5 | 6 | 7 | 6 | 14 | 10 | 5 | 6 | 5 |
| Cone game, Week 4 | 6 | 7 | 8 | 14 | 6 | 11 | 5 | 11 | 9 | 8 |
| Cone game, Week 5 | 13 | 5 | 11 | 14 | 10 | 12 | 7 | 8 | 5 | 5 |

## 4.4. Opinions of Students with ID about the Shape Finder Application

Interviews were conducted with the participant students in order to assure the social validity of the study. In the interviews, seven questions were asked to each student to garner their opinions and experience as users of the Shape Finder application (see Appendix H).

All of the students gave similarly positive answers, stating that they: enjoyed using the tablet computer in class; liked learning about the shapes with the tablet computer; had fun and enjoyed using the Shape Finder application; would like to share their experience with their friends; wanted their friends to learn using the application; liked everything about the application; found nothing that they did not like about the application; and lastly, they said that they wanted to learn everything by using tablet computers.

## 4.5. Opinions of Special Education Teachers and Experts about the Shape Finder Application

Interviews were conducted with the teachers of the participant students and special education experts in order to assure the social validity of the study. In the interviews of the teachers and experts, there were nine similar questions posed for each group (for teachers see Appendix J; for experts see Appendix K). The questions asked about their experience with DIM, their experience and opinion about the usage of technology in special education, and their opinion about the Shape Finder application and its appropriateness to DIM and to students with ID.

All of the interviews were later transcribed by the researcher, and then content analysis was conducted in order to reveal the themes and codes. These themes, subthemes, and codes are shown in Table 16. This shows that there were four main themes, which were demographics, features of the Direct Instruction Model, technology in class, and the Shape Finder application.

Table 16

*Coding Table for Special Education Teachers and Experts*

| *Theme* | *Subtheme* | *Code* |
|---|---|---|
| Demographics | Experience in DIM | Duration |
| Demographics | Experience in DIM | Purpose |
| Features of DIM | Basic Structure | Systematic |
| Features of DIM | Basic Structure | Teacher-centered |
| Features of DIM | Basic Structure | Standalone Application |
| Features of DIM | Basic Structure | Provision of Prerequisites |
| Features of DIM | Basic Structure | Practicality |
| Features of DIM | - | Consistence of Materials |
| Features of DIM | - | Relevance between Examples and Materials |
| Features of DIM | - | Usage Area |
| Technology in Class | - | Positive Attitude |
| Technology in Class | - | Necessity |
| Technology in Class | Advantages | Time Saving |
| Technology in Class | Advantages | Practicality |
| Technology in Class | Advantages | Motivation |
| Technology in Class | Advantages | Engagement |
| Technology in Class | Advantages | Effectiveness |
| Technology in Class | - | Lack of Technology |
| Technology in Class | - | Usage |
| Application | - | Appropriateness to DIM |
| Application | Advantages | Engagement |
| Application | Advantages | Fun |
| Application | Advantages | Visuality |
| Application | Advantages | Auditory |
| Application | Advantages | Effectiveness |
| Application | Advantages | Practicality |
| Application | Advantages | Relevancy to User Level |
| Application | - | Suggestions |
| Application | - | Transferability to Other Topics |
| Application | - | Opinions |

As can be seen in Table 16, the demographic theme contained one subtheme which was experience with the Direct Instruction Model, and that the subtheme had two codes which were duration and purpose. When the demographics were examined in detail, it could be seen that the three experts had been using DIM for approximately 10 years and that the others had been using it for approximately 3-5 years. Five of them mentioned that they were using this model for teaching purposes, whilst three mentioned using it in for internship. All of them had some experience with DIM. The other three main themes are explained in detail in the following subsections.

### 4.5.1. Features of Direct Instruction Model

In order to garner opinion about teachers' and experts' knowledge of the Direct Instruction Model, they were asked about what they considered were the main features of DIM. The data were grouped under four codes according to their answers. These codes were basic structure of DIM, consistency of materials, relevance between examples and materials, and usage area. Also, the teachers and experts gave detailed information about the basic structure of DIM, and this data became a subtheme with five codes. These codes were systematic, teacher-centered, standalone application, provision of pre-requisites, and practicality.

All of the experts mentioned that the Direct Instruction Model was a systematic model with its own principles such as presentation principle. One of the experts stated that:

> *The standard should be used when using or teaching the model; that is, it should not be differentiated from the method order of certain rules. So, you have to stick to the method.* (Expert-3)
>
> *Modelin eğitimini ya da öğretimini yaparken standart kullanılmalı, yani belli kurallarının yöntem sıralamasının vesaire farklılaşmaması lazım. Yani yönteme sadık kalınması lazım.* (Expert-3).

Another expert stated that:

> *We must first present more positive examples and then present negative examples. So, we need to implement by being careful with the rules.* (Expert-5)
>
> *Önce olumlu örnekleri daha fazla sayıda sunup, sonra olumsuz örnekleri de sunmamız gerekir. Yani, kurallarına dikkat ederek uygulamamız gerekir.* (Expert-5)

While talking about the basic structure of the model, two of the experts mentioned that the model is teacher-centered. They stated that because it is teacher-centered, the model corrects student mistakes very clearly and does not leave any margin for error. They also stated that while using in application, you need to be very careful.

Expert-2 also mentioned about the standalone application phase of the Direct Instruction Model, and the provision of prerequisites for students while talking about the basic structure of the model. Expert-2 said that while using this model, you should be careful in the standalone application phase, and added that:

> *We also need to pay attention to whether or not the children involved in the concept teaching have pre-condition skills about the concept.* (Expert-2)
>
> *Bir de uygulayacağımız kavramla ilgili çocukların ön koşul becerilerine sahip olup olmadığına dikkat etmemiz gerekiyor.* (Expert-2)

One expert mentioned the practical features of the Direct Instruction Model as the basic structure of the model, expressing that:

> *The Direct Instruction Model is a very practical method for concept teaching.* (Expert-4)
>
> *Kavram öğretimi için çok pratik bir yöntemdir doğrudan öğretim modeli.* (Expert-4)

Consistency of materials was one of the important features of DIM, according to the four experts. While using the Direct Instruction Model, materials should be carefully selected; they need to be made from the same materials and should be consistent.

> *Likewise, the materials used should be appropriate to the model.* (Expert-3)
>
> *Yine aynı şekilde kullanılan materyaller vesaire yönteme uygun olmalı.* (Expert-3)
>
> *When using the Direct Instruction Model, we should pay close attention to the examples we choose.* (Expert-5)
>
> *Doğrudan öğretim modelini kullanırken seçtiğimiz örneklere çok dikkat etmemiz gerekir.* (Expert-5)

Relevance between examples and materials is another important feature of the DIM, according to two of the experts. They explained that training material and example material should have similar characteristics while applying the model.

Another feature of the model mentioned by one expert was the usage area of the model. The expert especially stated that the model was very effective at this cognitive point, and that using this model in the education of students with intellectual disabilities could bring about successful studies.

In summary, it can be inferred that the teachers and experts found the Direct Instruction Model to be very effective, and that it is important to pay attention to its every feature in order to create really effective and successful teaching.

### 4.5.2. Technology in Class

Teachers and experts use technology in their daily life. However, for this study, it was important to know whether or not they were also using technology in the classroom, and what their opinions are about technology usage in the classroom. When the answers of the teachers and experts about technology usage in the classroom were examined, five subthemes emerged. These subthemes were positive attitude, necessity, advantages, lack of technology, and usage.

All of the teachers and experts expressed positive attitudes towards using technology in class. However, three of the experts also mentioned lack of technology in classes. One expert especially stated that:

> *So, if we can reach many more different technologies than teacher-made materials, it would be more useful for us and for our students – of course, this depends on the schools being attended and the opportunities available. I have a smartboard in my school, but no Internet. Of course, the smartboard is not very active when the Internet is not available. So you're expected to load something constantly.* (Expert-1)

> *Yani öğretmen yapımı materyallerden çok daha farklı teknolojilere ulaşabilirsek eğer, bu bizim için ve öğrenciler için daha kullanışlı olur – Tabi bu gidilen okullara ve ulaşılan imkanlara göre değişiyor. Yani benim şuanki çalıştığım okulda bir akıllı tahta var. Akıllı tahta var ama İnternet yok. Tabi akıllı tahtayı İnternet olmayınca çok aktifte kullanamıyorsunuz. Yani sizin sürekli bir şeyler yüklemeniz bekleniyor.* (Expert-1)

In addition, four of the experts also mentioned the necessity of having technology in the classroom, stating that:

> *We really need to use technology.* (Expert-1)

> *Teknolojiyi kullanmamız gerekiyor esasında.* (Expert-1)

> *Things that should be now.* (Expert-3)

> *Olması gereken şeyler artık.* (Expert-3)

*Absolutely necessary. Now that we are now in a revolution like the fourth-generation industrial revolution, everything is now going through technology, absolutely necessary – we are already trying to catch even the smallest things in our class.* (Expert-4)

*Kesinlikle gerekli. Ki zaten şuan artık 4.sanayi devrimi gibi bir döneme girdiğimiz dönemde artık her şey teknoloji üzerinden gidiyor kesinlikle çok gerekli – Dersimizde zaten mecburen hani en küçük şeylerde bile yakalamaya çalışıyoruz.* (Expert-4)

*Using technology in class is already advancing all over the world, so it is spreading through progress.* (Expert-6)

*Derste teknoloji kullanmak zaten bütün dünya da şey yaparak ilerliyor yani yayılarak ilerliyor.* (Expert-6)

Moreover, one teacher and three experts expressed that they were using technology in the classroom. The Teacher-1 said that he was using technology sometimes in math lessons. Expert-1 mentioned that because of the visuality of the technology, it was more useful. Another expert also said that:

*We are using it. With the Direct Instruction Model, that is, we did not do too much like this with tablets, but there are some things that we use, but different and varied applications. We use it with topics that we are dealing with on different issues of eye-tracking techniques. Here we use it as a model, a video model. So we use the technology in these things, and already the computer is a tool that we use all the time. We are using it.* (Expert-6)

*Kullanıyoruz. - Doğrudan öğretim modeliyle yani bu tarz tabletle uygulamalar çok fazla yapmadık ama daha farklı daha değişik uygulamalar kullandığımız bazı şeyler oldu. Daha farklı konularda göz izleme teknikleri ile ilgili çalıştığımız konularda kullanıyoruz. İşte model video model olarak kullanıyoruz. Yani teknolojiyi bu şeylerde kullanıyoruz zaten bilgisayar sürekli kullandığımız bir araç oluyor. Kullanıyoruz.* (Expert-6)

Two teachers and five experts explained the advantages of technology usage in class. One of them especially mentioned technology usage in class as time-saving:

*It saves time both for us and for the teaching of the students.* (Expert-1)

*Hem bizim açımızdan hem de öğrencinin öğretimi açısından zaman kazandırır.* (Expert-1)

Another expert mentioned about the technology as being practical:

*Of course, both in terms of practicality and in terms of the active participation of children in teaching, it is necessary.* (Expert-3)

*Hem pratiklik açısından hem de çocukların öğretime aktif olarak katılması açısından tabi ki gerekiyor.* (Expert-3)

Two experts said that using technology in class increases motivation and engagement:

> *I think positively because it increases the motivation and attention of the students.* (Teacher-2)
>
> *Öğrencilerin motivasyonunu ve dikkatini arttırdığı için olumlu düşünüyorum.* (Teacher-2)
>
> *Increasing interest – they listen carefully.* (Teacher-3)
>
> *İlgiyi arttırıyor – dikkatle dinliyorlar.* (Teacher-3)

Lastly, one teacher and three experts expressed opinions about the effectiveness of technology in class as the advantage of it. Especially two of them said that:

> *I think it will enable them to learn easily.* (Expert-5)
>
> *Daha kolay öğrenmelerini sağlayacağını düşünüyorum.* (Expert-5)
>
> *With our special needs students, we see that there are really effective works.* (Expert-6)
>
> *Bizim özel gereksinimli öğrencilerle de gerçekten etkili çalışmalar olduğunu görüyoruz.* (Expert-6)

In conclusion, all of the teachers and experts somehow used technology in their classes. They had positive attitudes towards using technology in the classroom, and found the technology to be a necessary tool, but that there were some problems like a lack of technology in some schools. Despite all the problems, they said that using technology in the classroom had many advantages, expressing these advantages as time saving, practical, increasing motivation, increasing engagement, and effectiveness.

### 4.5.3. Application

One of the main purposes of the interviews was to garner the opinions of teachers and experts about the Shape Finder application. Firstly, it was asked about the appropriateness of the application to the Direct Instruction Model. Each interviewee who mentioned the structure of DIM also mentioned the appropriateness of the developed application to DIM. According to the six experts and one teacher interviewed, while developing the Shape Finder application, every aspect of the Direct Instruction Model was paid adequate attention to, and that every step of the model had tried to be applied in the application. One of the experts said that:

> *I think what I saw was pretty good. So, it is certainly usable.* (Expert-1)
>
> *Bence şu an şu hali ile bile iyi gördüm. Yani kullanılabilir bir pozisyonda.* (Expert-1)

Another expert especially mentioned about the appropriateness of positive and negative examples, and the general appropriateness of the application to the DIM model:

> *I think it has been prepared in an appropriate way. I have observed that the positive and negative examples and all the other processes adhere to the model. I think it is appropriate – I saw them completely observe the process. It is quite appropriate, so there's nothing to criticize. All of the samples I have looked through have been transferred in a fully compliant way.* (Expert-2)
>
> *Ben uygun bir şekilde hazırlanmış olduğunu düşünüyorum olumlu örneklere olumsuz örneklere sıralamaya diğer tüm sürece uyulmuş olduğunu gördüm. Bence uygun. - Tamamen sürece uyulduğunu gördüm. Gayet uygun. Uygun yani söyleyecek eleştiri yapılacak bir şey yok şuanda. Baktığım bütün örneklerini sırasını tamamen gerekli şekilde aktarılmış.* (Expert-2)

In addition, one of them also talked about the appropriateness of examples, sorting and the questions:

> *Direct instruction is well-used in the application, that is, the progress of the program, etc. is appropriate to the model. Specified samples or sorting, questions, voices are all appropriate.* (Expert-3)
>
> *Doğrudan öğretimi iyi kullanılmış programda, yani, oyunun programın ilerlemesi vesaire yönteme uygun. Verilen örnekler ya da sıralama, sorular seslendirmeler uygun.* (Expert-3)

One of the experts found the application acceptable, but that the time required to use the application was a bit longer than expected. However, when students with intellectual disabilities were considered, it was accepted as normal:

> *I think that the things are very appropriate with the direct teaching method; that is, it should be as it should be – i.e. things are very nice, so obviously, it is certainly appreciated by me – I only stuck around the time usage a little, but the waiting times are fairly normal considering the users are children affected by intellectual disability.* (Expert-4)
>
> *Ya şeylere çok güzel uyulmuş bence doğrudan öğretim yöntemi ile yani olması gerektiği gibi olmuş - Yani şeyler çok güzel yani net zaten belli, o benim en çok hoşuma giden tarafları oldu. - Sadece o süre noktasına biraz takılmıştım ama zihinsel yetersizlikten etkilenen çocukları düşününce bekleme süreleri de gayet normal.* (Expert-4)

Other two experts and one teacher also mentioned that the application was designed in very appropriate way:

> *Examples of practice in the application sorting method are nicely converted to a game. In this study, the applications are arranged in accordance with the steps in terms of Direct Instruction Model. I did not experience any inconvenience or trouble. So it was suitable – a good job has been done in combining the Direct Instruction Model with the technology.* (Expert-5)

> *Uygulamada seçilen örnekler işte sıralama yöntem güzel oyunlanmış - Yapılan bu çalışmadaki uygulamalar doğrudan öğretim modeli açısından baktığımızda basamaklara uygun olarak uygulanmış yerleştirilmiş. Sakınca ya da bir sıkıntı görmedim. Yani uygun bir çalışma olmuş. - Doğrudan öğretim modelini teknoloji ile birleştirerek güzel bir çalışma olmuş.* (Expert-5)

> *So it has already been suitable for all stages of direct instruction model because of the direct instruction model is an effective method so I think it overlapped with the nature of the model.* (Expert-6)

> *Yani doğrudan öğretim modelinin zaten tüm basamaklarına uygun olmuş doğrudan öğretim modeli de şey olduğu için etkili bir yöntem olduğu için bu da bence örtüşmüş modelin şeyiyle doğasıyla.* (Expert-6)

> *It was created by paying attention to all phases of special education.* (Teacher-3)

> *Özel eğitimdeki tüm aşamalara dikkat ederek yapılmış.* (Teacher-3)

Another subtheme of the application theme was the advantages of the application. Each of the participant experts and teachers mentioned the advantages of the application. According to their expressions seven codes emerged in transcriptions. These codes were engagement, fun, visuality, auditory, effectiveness, practicality, and relevance to user level. In other words, according to the experts and teachers, the developed application provided advantages to students with intellectual disabilities. One of the experts especially said about engagement that:

> *I think that children will be interested – I think that it is a method that will make it easier for students to learn by making teaching easier and appealing – When you do it in this way, that is, with real objects, children may not be very interested. Playing in this way will capture the attention of children more so that they learn more easily.* (Expert-5)

> *çocuklarda istek uyandıracağını düşünüyorum – Yani öğrencilere öğretim daha kolay ve sevdirerek öğrenmelerini kolaylaştıracağı bir yöntem olduğunu düşünüyorum – Bu şekilde yani gerçek nesnelerle yaptığınızda çocukların çok ilgisini çekmeyebilir. Bu şekilde oyunlaştırmak çocukları daha çok ilgi göstererek böylece daha kolay öğrenmelerini sağlayacaktır.* (Expert-5)

Two teachers and four experts found the application fun, with two especially saying:

> *It's beautiful and really fun – Expansion is also a really nice game too, and also fun.* (Expert-4)
>
> *Çok güzel olmuş ve çok eğlenceli. - Genişletme de gerçekten güzel oyun çok eğlenceli - Hem çok eğlenceli.* (Expert-4)
>
> *Students are waiting to play the application with enthusiasm.* (Teacher-3)
>
> *Öğrenciler heyecanla uygulamayı yapmayı bekliyor.* (Teacher-3)

Visuality was another advantage of the application according to the three experts. One of them expressed that:

> *Selected colors are very suitable. There were not very many distracting elements, so the visuals in the subject-oriented object were absorbing.* (Expert-2)
>
> *Seçilen renkler gayet uygundu. Çok dikkat dağıtıcı şeyler yoktu tamamen konuya odaklı şeyde görseller vardı.* (Expert-2)

Three of the experts liked the tone of the application voice, and one of them liked the verbal reinforcement feature:

> *But meanwhile the verbal reinforcement was used as a good feature.* (Expert-6)
>
> *Ama sözel pekiştireçler bu arada kullanılmış oda iyi bir özellik.* (Expert-6)

Effectiveness was another advantage of the application according to the three teachers and four experts. All of them said that the application was very effective; if it was used, it seemed to be efficient. Especially, one of the teachers whose students had used the application said that:

> *I think it has a positive effect on the students. As a result of the applications made by the students, I observed that students reached independency in these concepts.* (Teacher-2)
>
> *Öğrenciler üzerinde olumlu etkisi olduğunu düşünüyorum. Öğrencilerin yapılan uygulamalar sonucunda bu kavramlar da bağımsızlığa ulaştığını gözlemledim.* (Teacher-2)

According to one teacher and three experts, the application was deemed practical. It was easy to implement, and it provided practicality to the teaching of new concepts. In addition, five experts mentioned about the relevancy of the application to the user level as an advantage of the application. According to them, the application was very much appropriate to the specified students' levels and the reinforcements it gave were also seen as very appropriate for the students.

Three of the experts made suggestions about the Shape Finder application and these were placed under the suggestions subtheme. Expert-1 said that it was a good start, and that it would be good for them if it was developed. Expert-2 said that the red books and pink books could be a cause for confusion to some students; suggesting a change of such closely related colors. Expert-6 also expressed that the application could be used in the teaching of students with visual or hearing impairments by adding subtitles for the application voice. This would mean that the application would be applicable for almost every student who has some degree of difficulty or disability.

All of the experts and teachers agreed on the transferability of the application to other topics, which formed another subtheme to the application theme. All of them expressed that it would be possible to transfer the Shape Finder application to other topics like numbers, addition, subtraction, or to other concepts colors, things, etc.

Lastly, five of the experts also mentioned additional opinions about the application. They said that they loved the application, that it was a really nice application, and that it was a well-thought-out application.
In conclusion, all the teachers and experts liked the application, they found the application appropriate to the DIM, wanted to see more applications like it, wanted to use this kind of application in their classes, and expressed that the application could be transferable to other topics. The interviews took place also to ascertain the social validity of the study. Based on these findings, it can also be said that the social validity of the study is high.

### 4.6. Summary of Results

Results are presented in five main topics: contribution of Shape Finder application to cube, cylinder and cone shapes acquisition of students with intellectual disabilities, retention of students' labeling skills of newly learned shapes after training was completed, retention rates of students in generalization of newly learned shapes to different contexts after training was completed, opinions of students with ID about Shape Finder application and opinions of teachers and experts about Shape Finder application.

When the results of contribution of Shape Finder application to cube, cylinder and cone shapes acquisition of students with intellectual disabilities were summarized, they showed that whole participated students gained the cube, cylinder and cone shapes acquisition. While value of correct response rate of all student participants was 0% in baseline and probe sessions for all shapes, all student participants learned cube, cylinder and cone shapes 100% after training and generalization sessions with Shape Finder application. In addition, before and after trainings with Shape Finder application, 30 questions with real objects of cube, cylinder and cone shapes were asked students with ID. Before the trainings, all students answer rate was 0%. However, after trainings were completed, all four students were able to perform 100% success to generalize the learned shapes into different contexts by using the real object.

Second topic of the results is about the contribution of the Shape Finder application to the retention rate of labeling skills of students with ID on newly learned shapes in the weeks after the training had been completed. After the training sessions had been completed, all participated students with intellectual disabilities were able to write 100% of the shapes' names correctly. This indicates that all students remembered all of the shapes and their corresponding names in the 3rd, 4th, and 5th weeks after the training sessions; and had the ability to label each shape.

Third topic of the results is about the retention rates of students in generalization of newly learned shapes to different contexts after training was completed. The results for the 3rd, 4th, and 5th weeks' post-training were approximately the same for each shape for each participant student. Therefore, it can be said that the Shape Finder application had contributed to the generalization of newly learned shapes in different contexts in the 3rd, 4th, and 5th weeks after the training sessions had been completed by all participated students.

The opinions of students with ID about Shape Finder application is the fourth topic or the results. The results show that all students had positive opinion about the Shape Finder application, they liked playing the application, they said they want to play this type of applications in their lessons and also, they said that they wanted to learn everything by using tablet computers.

The last topic of the results is about the opinions of special education teachers and experts about the Shape Finder application. Opinions of teachers and experts were categorized under four themes: (1) Demographics (2) Features of Direct Instructional Model (3) Technology in class (4) Application. Especially in application themes teachers and experts expressed positive view towards the application, and they found the application very helpful and useful for students with intellectual disabilities. Opinions of participated students with intellectual disabilities, special education teachers and experts, were collected as social validity of the Shape Finder application. According to results of opinions of students, teachers and experts, the Shape Finder application was found as socially valid.

# CHAPTER 5

# DISCUSSION AND CONCLUSION

In this chapter, a discussion on the findings of the study is presented. Firstly, the effectiveness of the Shape Finder application and the opinions of students, teachers, and experts about the application will be discussed together with the results of previous studies. Then, practical implications and suggestions for future research will be presented.

## 5.1. Discussion on Effectiveness of Shape Finder Application

The aim of this study was to develop an application based on the Direct Instruction Model for concept teaching of students with intellectual disabilities, and then to examine the effectiveness of the application. For this purpose, the Shape Finder application was designed according to steps of the Direct Instruction Model. Three different 3-dimensional geometric shapes were selected in the design process of the application, these were the cube, cylinder, and the cone. Within the design process, a generalization game was also designed for each shape type.

In the design process of the application, a pilot study was undertaken so as to observe and determine any weaknesses and problems of the application. Four students with intellectual disabilities participated in the pilot study. As a result, minor issues were identified and resolved in order to make the application better and more resilient. The application was redesigned accordingly, and a final version developed.

In this study, multiple probe designs across behaviors (Kucera & Axelrod, 1995; Tawney et al., 1984) was used, which is one of single-subject research methods. Following the design, firstly, probe and baseline data should be collected for three behaviors, after that the first behavior should be given. By providing consistency in the teaching process of the first behavior and in the probe and baseline data for two behaviors, the second behavior should be given. Lastly, when consistency in the teaching process of the second behavior and in the probe and baseline data for the last behavior was assured, the last behavior should be given (Kırcaali-İftar, & Tekin, 1997). Each of these steps were executed in the data collection process of this study.

When the first research question of the study was considered, it was seen that the Shape Finder application was effective in the cube, cylinder, and cone, 3D geometric shapes acquisition of students with ID. When the graphical analyses were examined for first sub-question, it was seen that in the baseline and probe sessions, the correct response percentages of all the participants were 0% (zero percent). However, after all the training sessions with the Shape Finder application had been delivered, the correct response percentages of the all participants had increased to 100% for the labeling of each type of shape.

When the second sub-question of the study was considered, results showed that the Shape Finder application was effective on the generalization of newly learned shapes into different contexts by students with ID. All of the participant students were able to generalize all of the shapes when playing the generalization games of the application. In addition, when the third sub-question was considered, it was seen that all of the participants of the study were able to generalize the learned concepts of cube, cylinder, and cone shapes to real objects which were made from paper, cardboard, or plastic in different sizes and different colors. This meant that the Shape Finder application had contributed to the generalization of newly learned shapes to different contexts with using real objects by students with IDs.

When the second and third research questions were considered, it was seen that in the third, fourth, and fifth weeks after the training had been completed, all of the students were still able to remember the learned concepts, and sustained the ability to label the shapes with 100% accuracy and to generalize to different contexts.

The current effectiveness data of this research supports previous studies on the use of technology-based materials in special education to improve the academic skills of students with IDs (Armutçu, 2008; Aşçıoğlu, 1997; Kiswarday, 1996; Reis et al., 2010; Sharma & Swadia, 2016; Sugasawara & Yamamoto, 2007; Tanju, 2004). A similar study about the use of technology with appropriate teaching method was conducted by Eliçin, Yıkmış, and Cavkaytar (2015). The aim of Eliçin et al.'s study was to examine the effectiveness of a tablet computer program designed to teach functional reading skills to students with autism. The program was designed by the researchers according to functional reading instruction steps. In total, four autistic students aged 5-7 years participated in the study, which was undertaken five days a week over a period of five weeks at 30 minutes per day. The study was designed according to multiple probe design across behaviors, which is one of the single-subject research methods, and the findings were replicated across the participants. The results of Eliçin et al.'s (2015) study showed that the tablet computer program was effective on the acquisition of functional reading skills by all of the participant students, and that the students could also generalize and maintain their skills. The social validity data of the study also supported the research findings.

In another similar study by Karanfiller, Göksu, and Yurtkan (2017), a mobile technology application was designed for students in special education. The aim of the study was the teaching of basic concepts to students in special education through a mobile application. The application was developed based on the staggering method and taught basic concepts like quantity, length, width, and size. The application was tested at two different schools. The results of the study showed that this developed application was applicable for use in the education of students in special education (Karanfiller, Göksu, & Yurtkan, 2017).

The effectiveness data of the current study also supports previous studies conducted in the special education field about the usage of instructional technologies for the improvement of social, emotional, and daily life skills of students with ID (Cakmak & Cakmak, 2015; Escobedo et al., 2012; Hourcade et al., 2012; Lozano et al., 2011; Mechling, Gast, & Barthold, 2003; Shelton, 2016; Tang et al., 2013).

The similar part of the current study and the previous studies is using technology in special education. However, while creating a technology-based material or integrating technology in special education, previous studies used different instructional methods. In addition to that the Direct Instruction Model which is used in the current study was confused with the direct instruction which is described by Rosenshine (Gersten, Woodward &Darch, 1986; Stein, Carnine & Dixon, 1998; Tuncer & Altunay, 2012). Structured teaching practices, called as direct instruction, are generally characterized by the division of skills into smaller steps and to provide students to reach independence by reducing the amount of teacher assistance. The Direct Teaching Model is separated from direct instruction practices by its specific applications related to an instruction program aimed a strategic integration, detailed instructional formats for teaching different information formats, classroom arrangement and management and by focusing on student progress (Tuncer & Altunay, 2012).

In addition to that, the literature showed that the Direct Instruction Model is effective on education of students with intellectual disabilities. By creating an application based on this model, it is aimed to support this effectiveness with a technology-based material in order to provide more variety in examples of the concept that wanted to be taught to students with intellectual disabilities. Therefore, while designing the Shape Finder application, it has been paid more attention to three main components; program design, organization of instruction, and Student-teacher interaction (Tuncer & Altunay, 2012; Watkins & Slocum, 2003). With this technology-based material, it is aimed to make learning more efficient and effective in the minimum time for students with intellectual disabilities. The results showed that this aim was reached with the Shape Finder application, all participated students learned the cube, cylinder and cone shapes and each shape was learned between approximately 15 and 22 minutes.

Therefore, with this study, it can be said that in Turkey, the first technology-based material with Direct Instruction Model on concept acquisition of students with ID was developed.

## 5.2. Discussion on Opinions of Students, Teachers and Experts about the Shape Finder Application

When the fourth research question was considered, opinions of the participant students about the Shape Finder application were collected via interviews. The results of the interviews together with the observations of the researcher revealed that all of the participant students with intellectual disabilities liked the tablet application and enjoyed using it. The tablet application attracted their attention and managed to sustain their attention for a longer time when compared to normal classroom lessons. The visual and audio content of the application also helped to attract the students' attention. The reactions of the students with intellectual disabilities were very good towards the tablet application. In the interviews, all of the students said that they wanted to use this kind of applications in all their lessons.

In addition, when the fifth research question of the study was considered, the opinions of the teachers of the participant students and experts on special education were collected via interviews. These opinions constituted the social validity findings of the study, and showed that all of the participant teachers and experts held positive opinions about the Shape Finder application and that they found the application to be effective in the teaching of concepts. They especially expressed their opinion about the appropriateness of the application to the Direct Instruction Model, which was used as a baseline for the design of the application. According to the six experts and one teacher, while developing the Shape Finder application, every aspect of the Direct Instruction Model had been paid attention to, and that every step of the model had tried to be applied in the application. When this result was evaluated with the effectiveness data of teaching the concepts, it can be said that using an appropriate teaching model in the design of an application contributed to the teaching of desired concepts to students with ID. This result supports previous studies in the literature (Altınay et al., 2016; Tanju, 2004; Tanju & Gönen, 2006).

In addition, the teachers and experts also mentioned that students with IDs were interested in using tablet computers and that this positively affected their learning. According to them, technology should be used in special education as well as mainstream education. Participants expressed that using technology in the classroom has advantages, and that these advantages are saving time, practicality, providing motivation, engagement, and being effective. These findings of the current study also support previous studies in this area (Hackbarth, 1996; Tiene & Luft, 2001). However, the interviewed teachers and experts also stated that there was not enough time to use technology in class, whilst in some classes there was no technology available to use anyway.

The participants also mentioned the advantages of the Shape Finder application for students with ID. According to their statements, the application increased user engagement; students experienced fun while using it; the application is very visual and auditory; it is both effective and practical; and is very appropriate to level of the intended users. These expressions also support components of the Direct Instruction Model (Tuncer & Altunay, 2012; Watkins & Slocum, 2003).

The current study can be seen as important as it revealed an original tablet application which had combined the Direct Instruction Model with technology. Furthermore, this study can guide future studies in the design of technology-based materials with teaching methods appropriate to the intended user base.

### 5.3. Practical Implications for Special Education Teachers/Parents

The results of the study convey a number of practical implications for special education teachers and parents of children with intellectual disabilities. According to the results, it is possible to teach concepts using technology-based materials designed based on appropriate teaching methods. In addition, a desktop computer/laptop version of the Shape Finder application will be available on the Educational Informatics Network (EBA) website which is designed as part of the FATIH Project by the Ministry of National Education in Turkey. Teachers and parents will then be able to download the application. However, while using the application they should adhere to the instructions listed as follows:

- The computer requires audio playback capability as the application provides an element of verbal instruction to users;
- Screen size of the application needs to be selected at startup;
- The application gives all three concepts in sequence and has a one-minute break time between each concept. If teachers or parents want to teach only one concept at a time, they should stay with the students or children in order to limit the usage to a single concept. However, if they want to teach all of the concepts at one time, they can leave the students or children alone, because the application provides all the necessary user instruction whilst using the application;
- The application stores all responses of the user, so teachers or parents can check them whenever they want;
- More than one user can be added to the application. Each user can follow their own progress by selecting their own name at the beginning of the application.

By using the application, teachers and parents should also consider that their students or children should have some of the following characteristics:

- Able to read and write;
- Able to label and distinguish 100% of the concepts of triangle, square, circle, and rectangle from two dimensional geometric shapes when examples are shown and asked, “What is this?”
- Able to fulfill the guidelines;
- (In expansion activities) Able to label the red, green colors, book, table, box, blackboard, pencil, rubber concepts and in, on, under, near which are the prepositions of place;
- Able to use a desktop computer/laptop.

### 5.4. Suggestions for Future Research

This study focused on investigating the effectiveness of computer-aided concept teaching based on the Direct Instruction Model for cube, cylinder, and cone concept acquisition, and the retention of students with intellectual disabilities. At the end of the study, results with regard to the effectiveness of the Shape Finder application, and the opinions of participant students, teachers, and experts were concluded. Therefore, this study provides certain perspectives about designing technology-based material based on appropriate teaching method, and the effectiveness of using this designed application in education of students with ID. Nevertheless, future studies would be needed in following areas:

- There has been a lack of study about using technology-enhanced material with appropriate teaching methods in special education. For this reason, new kinds of technology-based materials could be developed based on other appropriate teaching methods, and studies can be conducted about the effectiveness of such newly designed applications.
- In the current study, the Shape Finder application was designed for the teaching of concepts, which is one form of information according to the DIM, and previous literature on simple concepts or simple skills acquisition. For this reason, any new application could be designed and examined in order to teach the other three forms of instruction, which are verbal associations, rule relations, and cognitive strategies.
- The current study was conducted with students diagnosed with mild ID. The effectiveness of the developed application could be examined in the education of students with normal development or with different levels of disability.
- The current study was conducted according to the single-subject research method. By using this Shape Finder application experimental design research method can be conducted.

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# APPENDICES

# APPENDIX A

## PARENT CONSENT FORM

Sayın Veliler,

Orta Doğu Teknik Üniversitesi Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü doktora öğrencisi Mehtap Tufan olarak doktora tez çalışması için "Doğrudan Öğretim Modeli' ne Göre Bilgisayar Destekli Kavram Öğretiminin, Zihinsel Engelli Çocukların Kavramları Edinmeleri ve Kalıcılık Üzerine Etkisi" başlıklı araştırmayı yürütmekteyim. Araştırmamızın amacı Doğrudan Öğretim Modeli kullanılarak günümüz yaygın teknolojilerinden biri olan tablet bilgisayarlar ile kavram öğretimini sağlamaya yardımcı bir uygulama geliştirerek, zihinsel engelli öğrencilerde kavram öğretiminde bu programı kullanarak etkililiğini ölçmektir. Bu amacı gerçekleştirebilmek için çocuklarınızın tablet bilgisayar uygulamasını kullanmasına ihtiyaç duymaktayız.

Katılmasına izin verdiğiniz takdirde çocuğunuz okulda ders saatinde kavram öğrenirken tablet bilgisayar uygulaması kullanacaktır. Çocuğunuzun kullanacağı tablet bilgisayar uygulaması içerisinde onun psikolojik gelişimine olumsuz etkisi olacak hiçbir unsur yer almayacağından emin olabilirsiniz. Çocuğunuzun kullanacağı uygulama içerisindeki sorulara verdiği cevaplar kesinlikle gizli tutulacak ve bu cevaplar sadece bilimsel araştırma amacıyla kullanılacaktır. Bu formu imzaladıktan sonra çocuğunuz katılımcılıktan ayrılma hakkına sahiptir. Araştırma sonuçlarının özeti tarafımdan okula ulaştırılacaktır.

Çocuklarınızın tablet bilgisayar uygulamasını kullanarak sağlayacağı bilgiler tablet bilgisayarda Doğrudan Öğretim Modeli'ne göre hazırlanmış olan kavram öğretimi uygulamasının, çocukların tablet bilgisayar uygulaması kullanarak kavram öğrenmelerinin etkililiğinin saptanmasında önemli bir katkıda bulunacaktır. Araştırmayla ilgili sorularınızı aşağıdaki e-posta adresini veya telefon numarasını kullanarak bana yöneltebilirsiniz.

Saygılarımla,

Mehtap Tufan

Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü
Doktora Öğrencisi

*Lütfen bu araştırmaya katılmak konusundaki tercihinizi aşağıdaki seçeneklerden size en uygun gelenin altına imzanızı atarak belirtiniz ve bu formu çocuğunuzla okula geri gönderiniz.*

Yukarıda açıklamasını okuduğum çalışmaya, oğlum/kızım _____________________'nin katılımına izin **veriyorum**. Ebeveynin:

Adı, soyadı: _________________________ İmzası: ______________________
Tarih: ______________

Yukarıda açıklamasını okuduğum çalışmaya, oğlum/kızım _____________________'nin katılımına izin **vermiyorum**. Ebeveynin:

Adı, soyadı: _________________________ İmzası: ______________________
Tarih: ______________

# APPENDIX B

## INFORMED CONSENT FORM

Bu çalışma, Mehtap Tufan tarafından doktora tezi için gerçekleştirilen bir çalışmadır. Çalışmanın amacı, zihinsel engelli öğrencilere yönelik tablet bilgisayarda kullanılmak için geliştirilmiş olan kavram öğretimi uygulamasının öğrencilerin kavramı öğrenmeleri üzerine etkisi hakkında bilgi edinmektir. Çalışmaya katılım tamimiyle gönüllülük temelinde olmalıdır. Mülakatta, sizden kimlik belirleyici hiçbir bilgi istenmemektedir. Mülakat kayıt altına alınacaktır. Ancak cevaplarınız tamimiyle gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir; elde edilecek bilgiler bilimsel yayımlarda kullanılacaktır.

Mülakatta, genel olarak kişisel rahatsızlık verecek soruları içermemektedir. Ancak, katılım sırasında sorulardan ya da herhangi başka bir nedenden ötürü kendinizi rahatsız hissederseniz cevaplama işini yarıda bırakıp mülakatı bitirmekte serbestsiniz. Böyle bir durumda soruları soran kişiye, mülakatı tamamlamak istemediğinizi söylemek yeterli olacaktır. Mülakat sonunda, bu çalışmayla ilgili sorularınız cevaplanacaktır. Bu çalışmaya katıldığınız için şimdiden teşekkür ederiz.

***Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum***. (Formu doldurup imzaladıktan sonra uygulayıcıya geri veriniz).

İsim Soyisim Tarih

İmza ----/----/-----

## APPENDIX C

## GENERAL INFORMATION FORM

## GENEL BİLGİ FORMU

Tarih: …../..../……..

Ankete cevap veren kişinin

Adı Soyadı:

Çocuğa Yakınlık Derecesi:

Engelli Çocuğa Ait Bilgiler:

1- Adı Soyadı:
2- Cinsiyeti:
3- Doğum Tarihi:
4- Engelinin Türü: (*Aşağıdaki seçeneklerden birini seçiniz*.)
   a- Zihinsel            b- Zihinsel + Fiziksel
5- Öğrenim Durumu: (*Aşağıdaki seçeneklerden birini seçiniz*.)
   a. Bir İlköğretim bünyesinde kaynaştırma programına ve Merkezde özel eğitim takip programına devam ediyor.
   b. Özel alt sınıf programına ve Merkezde özel eğitim takip programına devam ediyor.
   c. Yalnızca özel eğitim programına devam ediyor.
6- Öğrenim gördüğü okulların adları:
7- Okuldaki sınıf seviyesi:
8- Engel Seviyesi: (*Aşağıdaki seçeneklerden birini seçiniz*.)

a- Ağır b- Orta c- Hafif

9- IQ Seviyesi:

10- Öğrencinin bildiği 2 boyutlu ve 3 boyutlu geometrik şekiller nelerdir?

11- Öğrenci aşağıda listelenmiş olan kavramları biliyor mu? Biliyor ise yanına + işareti, bilmiyor ise yanına – işareti koyunuz.

a. Kırmızı
b. Yeşil
c. Tahta
d. Kitap
e. Masa
f. Kutu
g. Kalem
h. Cetvel
i. Yanına
j. Altına
k. Üstüne
l. İçine

# APPENDIX D

## OBSERVATION FORM

**GÖZLEM FORMU**

**Gözlemci:**

**Gözlem Tarihi:**

**Uygulamada Gözlenen Kavram:**

| | | 1.Öğrenci | 2.Öğrenci | 3.Öğrenci | 4.Öğrenci | 5.Öğrenci | 6.Öğrenci |
|---|---|---|---|---|---|---|---|
| 1 | Uygulamayı açtı. | | | | | | |
| 2 | Uygulamada sesi dinleyip komutları tek başına yerine getirebildi. | | | | | | |
| 3 | Sorular arasında balonları patlattı. | | | | | | |
| 4 | Uygulamayı eğlenerek yapıyor | | | | | | |
| 5 | Uygulama sırasında gülüyor. | | | | | | |
| 6 | Hızlıca bitirmek istedi. | | | | | | |
| 7 | Çok oyalanarak yazıyor. | | | | | | |
| 8 | Uygulamadan sıkıldı. | | | | | | |
| 9 | Oyun kısmını eğlenerek yaptı. | | | | | | |
| 10 | Oyunu hızlıca bitirdi. | | | | | | |
| 11 | Uygulamayı kapattı | | | | | | |
| 12 | Uygulama dışında başka şeylerle ilgilendi. | | | | | | |
| 13 | Diğer notlar | | | | | | |

# APPENDIX E

# QUESTIONS FOR GENERALIZATION WITH REAL OBJECTS

## Genelleme için Öğrenciye Sorulacak Sorular

Masaya öğrencinin bilmediği 5 adet 3 boyutlu şekil (küp, silindir, koni, üçgen prizma ve küre) koyulur ve aşağıdaki durumları yapması istenir:

1) Küp şeklinde olanı kitaplığa koy.
2) Silindir şeklinde olanı kitaplığa koy.
3) Koni şeklinde olanı kitaplığa koy.

Masaya 2 adet küp, 2 adet koni, 3 adet silindir, 4 adet kare, 2 adet küre, 3 adet üçgen şekli koyulur ve aşağıdaki durumları yapması istenir:

4) Silindir şeklinde olanları sandalyeye koy.
5) Koni şeklinde olanları sandalyeye koy.
6) Küp şeklinde olanları sandalyeye koy.

Masaya aynı renklerde aynı sayıda küp, silindir, koni, kare, üçgen, küre, üçgen prizma şekilleri koyulur ve aşağıdaki durumları yapması istenir:

7) Koni şeklinde olanı masanın altına koy.
8) Küp şeklinde olanı masanın altına koy.
9) Silindir şeklinde olanı masanın altına koy.

Masaya farklı renklerde farklı sayılarda küp, silindir, koni, dikdörtgen, üçgen, daire, üçgen prizma şekilleri koyulur ve aşağıdaki durumları yapması istenir:

10) Kırmızı küpü masanın altına koy.
11) Kırmızı silindiri masanın altına koy.
12) Kırmızı koniyi masanın altına koy.

13) Mavi küpü yere koy.
14) Mavi silindiri yere koy.
15) Mavi koniyi yere koy.
16) Küpleri yan yana sırala.
17) Silindirleri yan yana sırala.
18) Konileri yan yana sırala.

Masaya farklı renklerde farklı sayılarda sadece küp, silindir ve koni şekilleri koyulur ve aşağıdaki durumları yapması istenir:

19) Silindirleri kutunun içine koy.
20) Konileri kutunun içine koy.
21) Küpleri kutunun içine koy.

Kutunun içerisine tüm şekiller koyulur ve aşağıdaki durumları yapması istenir:

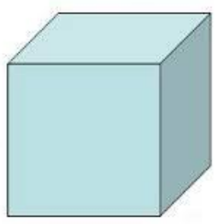
22) Sarı küpleri masanın üzerine koy.
23) Sarı silindirleri masanın üzerine koy.
24) Sarı konileri masanın üzerine koy.
25) Yeşil küpleri tahtanın altına koy.
26) Yeşil silindirleri tahtanın altına koy.
27) Yeşil konileri tahtanın altına koy.
28) Küplerin hepsini masanın üzerine sırala.
29) Konilerin hepsini masanın üzerine sırala.
30) Silindirlerin hepsini masanın üzerine sırala.

APPENDIX F

WORD DOCUMENT FOR CUBE SHAPE

**Ad Soyad:**

**Aşağıdakiler ne şeklinde?**



……………………..

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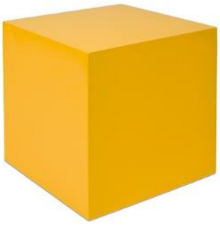
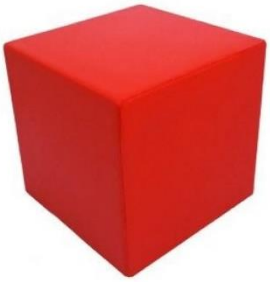
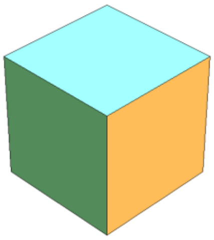


……………………..



……………………..



……………………..

……………………..

……………………..

……………………..

……………………..

## APPENDIX G

## CHECKLIST OF REAL OBJECTS' QUESTIONS

Table 17
*Checklist of Questions of Real Objects for All Participated Students*

| | | Öğr-1 | Öğr-2 | Öğr-3 | Öğr-4 | Öğr-5 | Öğr-6 |
|---|---|---|---|---|---|---|---|
| **1** | Küp şeklinde olanı kitaplığa koy. | | | | | | |
| **2** | Silindir şeklinde olanı kitaplığa koy. | | | | | | |
| **3** | Koni şeklinde olanı kitaplığa koy. | | | | | | |
| **4** | Silindir şeklinde olanları sandalyeye koy. | | | | | | |
| **5** | Koni şeklinde olanları sandalyeye koy. | | | | | | |
| **6** | Küp şeklinde olanları sandalyeye koy. | | | | | | |
| **7** | Koni şeklinde olanı masanın altına koy. | | | | | | |
| **8** | Küp şeklinde olanı masanın altına koy. | | | | | | |
| **9** | Silindir şeklinde olanı masanın altına koy. | | | | | | |
| **10** | Kırmızı küpü masanın altına koy. | | | | | | |
| **11** | Kırmızı silindiri masanın altına koy. | | | | | | |
| **12** | Kırmızı koniyi masanın altına koy. | | | | | | |

Table 17 (continued)

| | | | | | | | |
|---|---|---|---|---|---|---|---|
| **13** | Mavi küpü yere koy. | | | | | | |
| **14** | Mavi silindiri yere koy. | | | | | | |
| **15** | Mavi koniyi yere koy. | | | | | | |
| **16** | Küpleri yan yana sırala. | | | | | | |
| **17** | Silindirleri yan yana sırala. | | | | | | |
| **18** | Konileri yan yana sırala. | | | | | | |
| **19** | Silindirleri kutunun içine koy. | | | | | | |
| **20** | Konileri kutunun içine koy. | | | | | | |
| **21** | Küpleri kutunun içine koy. | | | | | | |
| **22** | Sarı küpleri masanın üzerine koy. | | | | | | |
| **23** | Sarı silindirleri masanın üzerine koy. | | | | | | |
| **24** | Sarı konileri masanın üzerine koy. | | | | | | |
| **25** | Yeşil küpleri tahtanın altına koy. | | | | | | |
| **26** | Yeşil silindirleri tahtanın altına koy. | | | | | | |
| **27** | Yeşil konileri tahtanın altına koy. | | | | | | |
| **28** | Küplerin hepsini masanın üzerine sırala. | | | | | | |
| **29** | Konilerin hepsini masanın üzerine sırala. | | | | | | |
| **30** | Silindirlerin hepsini masanın üzerine sırala. | | | | | | |

# APPENDIX H

## INTERVIEW QUESTIONS FOR STUDENTS

## ÖĞRENCİ GÖRÜŞLERİ HAKKINDA SORULAR

**1-** Derste tablet bilgisayar kullanmaktan hoşlandın mı?
**2-** Tablet bilgisayar ile küp, silindir ve koniyi öğrenmekten hoşlandın mı?
**3-** Küp, silindir ve koniyi tablet bilgisayar ile öğrenirken eğlendin mi?
**4-** Arkadaşlarının da tablet bilgisayar ile küp, silindir ve koniyi öğrenmesini ister misin?
**5-** Küp, silindir ve koniyi öğrenirken neleri beğendin?
**6-** Küp, silindir ve koniyi öğrenirken neleri beğenmedin?
**7-** Tablet bilgisayar ile başka neler öğrenmek istersin?

## APPENDIX I

## INTERVIEW QUESTIONS FOR TEACHERS

## ÖĞRETMENLERİN GÖRÜŞLERİ HAKKINDA SORULAR

**1-** Derslerinizde Doğrudan Öğretim Modeli'ni kullanıyor musunuz?
**2-** Derste teknolojinin kullanılması hakkında ne düşünüyorsunuz?
**3-** Küp, silindir ve koni kavramlarını derslerinizde nasıl öğretiyorsunuz?
**4-** Küp, silindir ve koni kavramlarının öğretildiği Doğrudan Öğretim Yöntemi ile geliştirilmiş olan tablet bilgisayar uygulaması hakkında ne düşünüyorsunuz?
**5-** Çalışmanın beğendiğiniz yönleri nelerdir?
**6-** Çalışmanın beğenmediğiniz yönleri nelerdir?
**7-** Bu uygulamanın kullanılması ile sınıf ortamında gördüğünüz değişiklikler nelerdir?
**8-** Öğretim sırasında ve sonrasında öğrencilerinizin derse olan tutumlarında değişiklikler oldu mu? Oldu ise bu değişiklikler nelerdir?
**9-** Böyle bir tablet bilgisayar uygulaması kullanarak diğer matematik becerilerini kazandırmak sizce mümkün mü?

# APPENDIX J

## INTERVIEW QUESTIONS FOR EXPERTS

## AKADEMİSYEN GÖRÜŞLERİ HAKKINDA SORULAR

**1-** Kaç yıldır Doğrudan Öğretim Modeli hakkında çalışıyorsunuz?
**2-** Doğrudan Öğretim Modeli ile ilgili ne tür çalışmalar yaptınız?
**3-** Doğrudan öğretim Modeli'ni kullanılırken dikkat edilmesi gereken noktalar nelerdir?
**4-** Derste teknolojinin kullanılması hakkında ne düşünüyorsunuz?
**5-** İncelemiş olduğunuz; küp, silindir ve koni kavramlarının öğretildiği Doğrudan Öğretim Modeli ile geliştirilmiş olan bu tablet bilgisayar uygulaması hakkında ne düşünüyorsunuz?
**6-** Çalışmanın beğendiğiniz yönleri nelerdir?
**7-** Çalışmanın beğenmediğiniz yönleri nelerdir?
**8-** Çalışmayı Doğrudan Öğretim Modeli açısından değerlendirdiğinizde neler söyleyebilirsiniz?
**9-** Böyle bir tablet bilgisayar uygulaması kullanarak diğer matematik becerilerini kazandırmak sizce mümkün mü?

## APPENDIX K

## PERMISSION OF ETHICAL COMMITTEE

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

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Sayı: 28620816/53-138

02.02.2015

Gönderilen : Prof. Dr. Soner Yıldırım
Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

Gönderen : Prof. Dr. Canan Sümer
IAK Başkan Vekili

İlgi : Etik Onayı

Danışmanlığını yapmış olduğunuz Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğrencisi Mehtap Tufan'ın "Doğrudan Öğretim Modeli'ne Göre Bilgisayar Destekli Kavram Öğretiminin, Zihinsel Engelli Çocukların Kavramları Edinmeleri ve Kalıcılık Üzerine Etkisi" isimli araştırması "İnsan Araştırmaları Komitesi" tarafından uygun görülerek gerekli onay verilmiştir.

Bilgilerinize saygılarımla sunarım.

Etik Komite Onayı

Uygundur

02/02/2015

Prof.Dr. Canan Sümer
Uygulamalı Etik Araştırma Merkezi
( UEAM ) BaşkanVekili
ODTÜ 06531 ANKARA

12/2 / E.Ç.

# APPENDIX L

# PERMISSION OF MINISTRY OF EDUCATION

T.C.
ANKARA VALİLİĞİ
Milli Eğitim Müdürlüğü

EĞİTİM
FAKÜLTESİ DEKANLIĞI
Ev. Arş. Md. Saat :

**Sayı** : 14588481/605.99/1863174 19/02/2015
**Konu:** Araştırma izni

ORTA DOĞU TEKNİK ÜNİVERSİTESİNE
(Eğitim Fakültesi)

İlgi: a) MEB Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 2012/13 nolu Genelgesi.
b) 06/02/2015 tarihli ve 29 sayılı yazınız.

Üniversiteniz Eğitim Fakültesi Doktora Öğrencisi Mehtap TUFAN' ın **"Doğrudan eğitim modeline göre bilgisayar destekli kavram öğretiminin, zihinsel engelli çocukların kavramları edinmeleri ve kalıcılık üzerine etkisi"** başlıklı tezi kapsamında çalışma yapma talebi Müdürlüğümüzce uygun görülmüş ve araştırmanın yapılacağı İlçe Milli Eğitim Müdürlüğüne bilgi verilmiştir.

Anket formunun (3 sayfa) araştırmacı tarafından uygulama yapılacak sayıda çoğaltılması ve çalışmanın bitiminde iki örneğinin (cd ortamında) Müdürlüğümüz Strateji Geliştirme (1) Şubesine gönderilmesini arz ederim.

Müberra OĞUZ
Müdür a.
Şube Müdürü

23.02.2015 - 3260 .

Güvenli Elektronik İmzalı
Aslı İle Aynıdır.
19/02/2015

SUBAŞI
Şef

Atatürk Blv. 06648 Kızılay/ANKARA
Elektronik Ağ: www.meb.gov.tr
e-posta: adsoyad@meb.gov.tr

Ayrıntılı bilgi için: Ad SOYAD Ünvan
Tel: (0 312) XXX XX XX
Faks: (0 312) XXX XX XX

Bu evrak güvenli elektronik imza ile imzalanmıştır. http://evraksorgu.meb.gov.tr adresinden cef0-946f-3c38-864e-8e6a kodu ile teyit edilebilir.

23/2 24/2 65

## CURRICULUM VITAE

### PERSONAL INFORMATION

Surname, Name: Tufan, Mehtap
Nationality: Turkish (TC)
Date and Place of Birth: 7 July 1987, Sakarya
Marital Status: Married
Email: mehtap-tufan@hotmail.com

### EDUCATION

| Degree | Institution | Year of Graduation |
|---|---|---|
| BS | METU Computer Edu. and Inst. Tech. | 2010 |
| High School | Sakarya Anatolian Girl Vocational High School | 2005 |

### WORK EXPERIENCE

| Year | Place | Enrollment |
|---|---|---|
| 2018- | TEDU Center for Teaching & Learning | Assistant Expert |
| 2017-2018 | LearnEra Education and Consultancy | Training Doc. Interpreter |
| 2016-2017 | Private Beştepe Schools | Cambridge ICT Teacher |
| 2013-2015 | Bilge Communication Company | Instructional Technologist |
| 2011-2012 | METU Computer Edu. and Inst. Tech. | Research Assistant |

### FOREIGN LANGUAGES

Advanced English

## PUBLICATIONS

### *Conference Proceedings*

1.İslim, Ö. F., Çırak, N., Kilis, S. & Tufan, M. (2017, Mayıs) Anxiety level of preservice science teachers toward using educational technology. İnönü University 11. International CEIT Symposium, Malatya.

2.Sevim, N., Tufan, M., & Efe, A. (2014, September). Inspection of education information network (eba) modules and user statistics analysis. Trakya University 8. International CEIT Symposium, Edirne (pp. 100-103).

3.Tufan, M., Yıldırım, S., Altunay, B., & Özmen, R. (2014, Eylül). What covenants the use of instructional technology with Direct Instruction model for children with intellectual disabilities?. Trakya University 8. International CEIT Symposium, Edirne.

4.Çiçek, M., Çiçek, F., Yılmaz, Y., Tuzlu, M., & Yıldırım, S. (2013). The FATIH project: Through the lens of computer teachers and classroom teachers. Paper presented at 7th International Computer and Instructional Technologies Symposium, Erzurum, 6-8 June 2013 (pp. 95-96).

## COMPUTER SKILLS

***Programming Languages:*** Pascal, Turbo C, C#, C++, Visual Basic, Java Script, Java
***Web Technologies:*** HTML, CSS, WordPress,
***Development Applications:*** Visual Studio, SQL Server, Adobe Photoshop, Adobe Flash, Adobe Dreamweaver, Eclipse, Camtasia Studio,
***Microsoft Applications:*** MS Office (Word, Excel, Access, Power Point, Publisher), MS Expression Studio (Blend, Encoder, Design, Web), LCDS, MS Windows LOGO, Song Smith, Photosynth, Auto Collage, Movie Maker
***Web 2.0 Tools:*** Prezi**,** Powtoon, Toondoo, GoAnimate, Kahoot, Glogster, Piktochart.

## AWARDS

Turkey Accessible Informatics Platform - Accessible Informatics Awards 2017 Student Project Award for Shape Finder Application

## HOBBIES

Reading books, traveling, listening to music, watching movies, playing guitar, playing volleyball and tennis.