INVESTIGATING THE DESIGN, DEVELOPMENT, AND EVALUATION OF A HIGH-TECH ALTERNATIVE AND AUGMENTATIVE COMMUNICATION (AAC) APPLICATION FOR COMMUNICATION NEEDS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDERS

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ABSTRACT

INVESTIGATING THE DESIGN, DEVELOPMENT, AND EVALUATION OF A HIGH-TECH ALTERNATIVE AND AUGMENTATIVE COMMUNICATION (AAC) APPLICATION FOR COMMUNICATION NEEDS OF INDIVIDUALS WITH AUTISM SPECTRUM DISORDERS

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Autism Spectrum Disorder (ASD) is a type of neurodevelopmental disorder that has two core symptoms; (i) absence of social communication and interaction, and (ii) presence of atypical behaviors. To deal with these symptoms, different treatment approaches such as Alternative and Augmentative Communication (AAC) are used for teaching communication skills to individuals with ASD. With the advancements in mobile technologies, practitioners in special education started to use high-tech aided AAC systems for communication treatments. A variety of high-tech AAC systems were investigated in the special education literature. However, limited number of studies focused on the design requirements of AAC systems from the instructional material design perspective. In this regard, the purpose of this study is to investigate the design, development, and evaluation of a high-tech AAC application for communication needs of individuals with ASD. A design based research framework including multiple research methods was employed in the present study. Two types of data were collected throughout the process related to (i) the design specifications of AAC applications and (ii) the effectiveness of an AAC application on functional communication, which was designed depending on these specifications. In order to reveal the design specifications of the AAC applications, a focus group study, and two expert reviews were conducted with special education teachers and academicians in the field. Results indicated several design specifications referring to the functionality, flexibility, usability and appealing of the mobile application. Based on these design specifications, an AAC application named EBA which stands for the Turkish expression “Engelleri Birlikte Aşalım”(Lets Overcome the Obstacles Together) was developed after three iteration process. The EBA was applied with the instructional strategies of Picture Exchange Communication System (PECS) protocols to three children with ASD in the evaluation phase. The findings indicated that the EBA is an effective high-tech AAC application in facilitating functional communication and requesting skills of individuals with ASD.

Keywords: Autism Spectrum Disorder, Alternative and Augmentative Communication, Functional Communication, Design Specifications, Design Based Research

ÖZ

OTİZM SPEKTRUM BOZUKLUĞU TANILI BİREYLERİN İLETİŞİM GEREKSİNİMLERİNE YÖNELİK, BİR İLERİ TEKNOLOJİ ALTERNATİF DESTEKLEYİCİ İLETİŞİM SİSTEMİNİN TASARLANMASININ, GELİŞTİRİLMESİNİN VE DEĞERLENDİRİLMESİNİN ARAŞTIRILMASI

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Otizm Spektrum Bozukluğu (OSB) iki temel belirtisi olan nörogelişimsel bir bozukluktur. Bu iki belirti, (i) bireylerde sosyal iletişim ve etkileşim eksikliği ve (ii) tipik olmayan istenmeyen davranışların gözlemlenmesi durumudur. Bu durumlarla başa çıkmak için, Alternatif ve Destekleyici İletişim Sistemler (ADiS) gibi farklı sağaltım yöntemleri OSB' li bireylere iletişim becerisi öğretmek için kullanılmaktadır. Mobil teknolojilerdeki gelişmelerle birlikte, ileri teknoloji ADiS sistemleri özel eğitim uygulayıcıları tarafından iletişimi iyileştirme aracı olarak kullanılmaya başlamıştır. Özel eğitim alan yazınında ileri teknoloji ADiS kullanımına yönelik birçok çalışma bulunmaktadır. Ancak ADiS sistemlerinin tasarım gereksinimlerini öğretim materyali tasarım perspektifiyle inceleyen sınırlı sayıda çalışma bulunmaktadır. Bu bağlamda, bu çalışmanın amacı, OSB'li bireylere iletişim becerisi kazandırmaya yönelik bir mobil uygulamanın tasarlamasının, geliştirilmesinin ve değerlendirilmesinin araştırılmasıdır. Çalışmada içerisinde farklı araştırma desenleri bulunan tasarım tabanlı araştırma yöntemi kullanılmıştır. Araştırma sürecinde, (i) ADiS uygulamalarının tasarım ilkeleri ve (ii) bu ilkelere göre tasarlanmış bir ADiS uygulamasının işlevsel iletişime olan etkisiyle ilgili iki boyutta veri toplanmıştır. Tasarım ilkelerini ortaya koymak için özel eğitim öğretmenleri ve alan akademisyenleri ile odak grup görüşmesi ve uzman değerlendirme çalışmaları yapılmıştır. Araştırma sonucunda mobil uygulamanın işlevselliğine, esnekliğine, kullanılabilirliğine ve görünümüne yönelik bazı tasarım ilkelerine ulaşılmıştır. Bu tasarım ilkeleri temel alınarak üç özyineleme süreci sonunda EBA (Engelleri Birlikte Aşalım) adında bir ADiS uygulaması geliştirilmiştir. Uygulama, Resim Değiş-Tokuşuna Dayalı İletişim Sistemi (PECS) protokollerinde yer alan öğretim stratejileriyle birlikte üç OSB'li çocuk tarafından kullanılmıştır. Değerlendirme sonucunda, EBA'nın işlevsel iletişimi ve OSB'li bireylerin ifade edici dil becerisi gelişimini desteklediğine yönelik pozitif bulgulara ulaşılmıştır.

Anahtar Kelimeler: Otizm Spektrum Bozukluğu, Alternatif Destekleyici İletişim Sistemleri, İşlevsel İletişim, Tasarım İlkeleri, Tasarım Tabanlı Araştırma

To my dear family

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ABBREVIATIONS

AAC	Alternative and Augmentative Communication
ABA	Applied Behavior Analysis
APA	American Psychiatric Association
ASD	Autism Spectrum Disorder
DBR	Design Based Research
DSM-V-TR	Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision
EBA	Engelleri Birlikte Aşalım
PECS	Picture Exchange Communication System
SGD	Speech Generating Device
VOCA	Voice Output Communication Aid

CHAPTER 1

INTRODUCTION

This chapter focuses on the justification of the current study. Firstly, an introduction was made in background of the study to make readers familiar to the topic. Then, the problem statement, purpose, significance, and research questions of the study were presented. After that, operational definitions of the frequently used terms were introduced. Finally, the organization of the study briefly presented.

1.1. Background of the Study

The symptoms of *autism* were first observed by Kanner (1943). The concept was then investigated by a variety of researchers. Based on the clinical studies, it was named as Pervasive Developmental Disorders (PDD) at the DSM-IV-TR (American Psychiatric Association, 2000). Instead of PDD, the term of Autism Spectrum Disorder (ASD) was preferred in the Diagnostic and Statistical Manual of Mental Disorders, Fifth Edition, Text Revision (DSM-V-TR) (American Psychiatric Association [APA], 2013). According to last definition, ASD is a neurodevelopmental disorder that have two essential symptoms "*(1) persistent impairment in reciprocal social communication and social interaction and (2) restricted repetitive patterns of behavior, interests, or activities*" (APA, 2013, p.53). As the definition implies, impairments in social reciprocity and communication, and presence of atypical behaviors are the core symptoms of ASD.

There are five diagnostic criteria of ASD (American Psychiatric Association, 2013). The first and the most important criterion is the persistent deficits in social communication and interaction. The second criterion is the presence of restrictive, repetitive, stereotyped, and self-injured behaviors. Third, previous two symptoms must be seen on the early developmental age of children. Forth, these symptoms must cause social impairments in the daily life of the patients. Last, due to the similar characteristics of both ASD and other intellectual disabilities, they can be confusable, and co-occur occasionally. Thus, these deficits should not be attributed to the intellectual disabilities. By taking all these criteria into account, American Psychiatric Association (2013) proposed three severity levels: requiring support, requiring substantial support, and requiring very substantial support.

As noted in DSM-V-TR, individuals with ASD or related disorders need certain services and support to sustain their life by themselves. Since impairments in social reciprocity and communication are the foremost diagnostic criteria of the ASD, individuals with ASD need more support on these issues. They experience varying degrees of difficulty in interpreting verbal and nonverbal expressions of other people including gestures, facial expressions, and emotional tones (Hyman & Levy, 2013). Instead of making eye contact with communication partners, they focus on mouths (Klin, Jones, Schultz, Volkmar, & Cohen, 2002). Additionally, language delay in infancy is frequently observed concern of parents whose child is later diagnosed with ASD (Hyman & Levy, 2013; Mitchell et al., 2006). Although it is possible to teach fluent speech to these children, many of them struggle to express themselves (Wodka, Mathy, & Kalb, 2013). There is empirical evidence that children with ASD or related disabilities have difficulty in both receptive and expressive language and thereby in communication (Hyman & Levy, 2013).

In order to improve the overall development of individuals with ASD, different treatment methods are used including educational and behavioral approaches, communication training, and medical support. Educational support is provided at schools either in special or inclusive classes (White, Scahill, Klin, Koenig, & Volkmar, 2007). Different instructional strategies are used during their education such as the use of reinforcement (Hyman & Levy, 2013), incidental learning (Mesibov, Shea, & Schopler, 2004), and structured teaching (Mesibov et al., 2004; Schopler, 1994). Behaviorist approaches, on the other hand, use the principles of behaviorist psychology. Applied Behavior Analysis (ABA) is one of these approaches and focuses on the treatment of socially important behaviors (Baer, Wolf, & Risley, 1968). Furthermore, communication training requires teamwork in which all the stakeholders study collaboratively (ASHA: National Joint Committee for the Communication Needs of Persons With Severe Disabilities, 1992). Before starting the communication treatment, speech-language pathologists determine the communication problem by using a standardized test and provide treatment appropriate to the problem situation. However, there is still no certain medicine to treat the core symptoms of ASD (Hyman & Levy, 2013).

Alternative learning opportunities that are based on individual learning programs may assist children with ASD to overcome the problems they face in society (Tsiopela & Jimoyiannis, 2017). Information and communication technologies (ICT) have potential to broaden these opportunities in special education. In this regard, a variety of studies have reported positive outcomes of such tools in the field. Intervention with multimedia tools, for example, was found effective in recognizing the complex emotions of the target group (Golan & Baron-Cohen, 2006). Additionally, virtual reality applications were reported as a good opportunity for enhancing the social skills of individuals with ASD (Parsons & Cobb, 2011). Particularly mobile devices have taken the interest of both educators and researchers in the recent years (Cumming & Draper Rodríguez, 2017a; Tsiopela & Jimoyiannis, 2017) due to their built-in flexibility (Cumming & Rodriguez, 2013) and the increasing number of applications developed for individuals with special needs. These technologies with network connection provide a good framework for lifelong learning by which learners may acquire knowledge and communicate with any stakeholder in any place related to the topic (Sharples, 2000). Intervention with mobile applications are not only accepted as less stigmatized in society (Lorah, Parnell, Whitby, & Hantula, 2015), but also give chance to the individuals with ASD to meet their needs anytime and anywhere. Given the diagnostic criteria of ASD, most of the mobile interventions were focused on the social communication needs (Alzrayer, Banda, & Koul, 2017; An et al., 2017; Genc-Tosun & Kurt, 2017; Nepo, Tincani, Axelrod, & Meszaros, 2017) and language skills (Ganz, Hong, Goodwyn, Kite, & Gilliland, 2015; Rodríguez & Cumming, 2017; Wojciechowski & Al-Musawi, 2017) of such individuals.

Providing communication support for people with ASD or severe communication impairments is a troublesome problem of speech-language pathologists (Mirenda, 2003), educators and practitioners. However, in order to improve their life conditions, it is crucial to struggle with this problem effectively. In this regard, Alternative and Augmentative Communication (AAC) is a fulfilling option for individuals with ASD and related disorders to support their existing speech and to provide an alternative method for expressing themselves (Mirenda, 2001, 2003; Romski & Sevcik, 2005). There are two main advantages of AAC: it helps individuals to learn communication through functional messages, and the rate of atypical and problematic behaviors decrease as they learn expressive language (Mirenda, 2001). In other words, AAC enhance communication skills in terms of either augmenting speech capability or giving alternative communication chance (Lorah, Parnell, Whitby, & Hantula, 2015).

AAC literature basically focus on improvement of different skills of individuals with communication impairments, including functional communication (Alzrayer, Banda, & Koul, 2017; Genc-Tosun & Kurt, 2017; Hart & Banda, 2009; Mirenda, 2003; Nepo, Tincani, Axelrod, & Meszaros, 2017; Tien, 2008), social language (Light, 1997; Romski & Sevcik, 2005; Wojciechowski & Al-Musawi, 2017), speech production (Gevarter et al., 2015; Millar, Light, & Schlosser, 2006). Functional communication is the common ground to which many researchers have referred frequently in the field.

The term Functional Communication Training (FCT) is a set of procedures used to reduce problematic behaviors of individuals with autism by teaching communication skills (Mirenda, 2001). It is the combination of several functions attributed to language during the communication. Skinner (1957) introduced a group of variables that account for these functions of communication, including “mand”, “tact”, “echoic”, “textual”, and “intraverbal”. “Mand” is the initial step of the functional communication, which is a specific response towards a certain reinforcement (Skinner, 1957). In more lay terms, it can be described as “requesting a desired object”. The fact is that once requesting skill is taught to individuals with communication impairments, the rate of challenging behaviors frequently observed on such individuals is decreased (Frea, Arnold, & Vittimberga, 2001; Hart & Banda, 2009; Mirenda, 2001; Schlosser & Koul, 2015; Tien, 2008).

Based on the criterion of whether any additional equipment is required for communication or not, AAC methods generally divided into two categories: aided and unaided (Alzrayer et al., 2017; Lorah et al., 2015; Mirenda, 2003; Moffatt, Pourshahid, & Baecker, 2017; Romski & Sevcik, 2005). Unaided AAC is employed to teach communication to individuals with ASD or other communication impairments and does not require any additional equipment (Mirenda, 2003). It is a form of nonverbal communication that includes gestures, manual sign language, and pantomimes. Any child who can use his/her hands and has fine motor controls can use this form of communication (Romski & Sevcik, 2005). However, it is very difficult to find someone who can understand and use the unaided AAC in society. That forces unaided AAC methods to mostly rely on the knowledge of communication partners (Lorah et al., 2015). For instance, the likelihood of encountering with a waiter or even an ordinary person who is familiar with sign language is low (Bondy & Frost, 1994) in society. In this case, the functionality of such language is questionable (Lorah et al., 2015). Additionally, characteristics of disabled individuals can be an obstacle to teach sign language. For example, any individual with developmental disabilities cannot use their motor skills to get unaided AAC effectively (Bondy & Frost, 1994; Mirenda, 2003). On the other hand, using an additional equipment (Mirenda, 2003) like a technological device makes communication aided. There have been different types of aided AACs such as Picture Exchange (PE), Picture Exchange Communication System (PECS) (Bondy & Frost, 1994), Speech Generating Devices (SGDs), or Voice Output Communication Devices (VOCA). It is not certain whether one of them is better than others to enhance functional communication. Instead, all of them have some advantages and disadvantages. Further, the application of such methods depends on the characteristics of individuals to whom they have been applied. However, aided AAC studies are more preferable than unaided AAC studies in the AAC literature (Logan, Iacono, & Trembath, 2017).

There are two types of aided AAC techniques: low-tech and high-tech aided AAC (Moffatt et al., 2017). Low-tech aided AAC technologies are simple tools by nature (Moffatt et al., 2017), however high-tech aided AAC technologies are complicated devices that have potential to process information. High-tech aided AAC techniques involve electronics (Moffatt et al., 2017) and also are known as Speech Generating Devices (SGDs) and Voice Output Communication Aids (VOCAs) (Nepo et al., 2017). Since touchscreen-based mobile devices have similar characteristics with SGDs, they are also used as a high-tech aided AAC. However, to optimize such devices for functional communication, the design of mobile applications is an important concern to which researchers need to pay more attention (Light, Drager, & Nemser, 2004; Light & Drager, 2002, 2007; Light, Page, Curran, & Pitkin, 2007). In this regard, Light and Drager (2007) categorized six future research dimensions related to the use of AAC technologies for individuals with communication impairments. Firstly, they urgently requested future research to understand preferences of both children with communication impairments and their families. Secondly, in order to meet communication needs of individuals, it is essential to redesign AAC technologies. Redesigning procedure should focus on (a) appeal of the AAC systems, (b) how to reduce learning demands through navigation system, output of the AAC, layout and organization, and selection technique, (c) just in time programming of AAC systems, (d) modification of AAC systems for qualitative and quantitative changes in child development, (e) supporting interactive contexts in which children and their parents can communicate, (f) how to make AAC technologies more functional, and (g) integration of developmentally suitable learning opportunities. Thirdly, future research should consider the design of AAC systems to help parents to implement the AAC technologies effectively. Fourthly, effective communication interventions are required to improve communication skills of individuals with communication impairments. Fifthly, further studies should increase the knowledge about AAC and public awareness about significance of the early intervention. Finally, there is a need for evidence based practices to decrease the gap between research and practice.

1.2. The Problem Statement

The number of children with Autism Spectrum Disorder (ASD) and related disabilities has increased in an accelerated rate. Turkish Statistical Institute published a report about statistics on children in 2014. The report included the distribution of discomforts seen in children for the years of 2008, 2010 and 2012, in Turkey. While the proportion of children with speech delay or defect, behavioral problems, and autism was approximately %7.9 in 2010, this rate increased to %9.2 in 2012 (TÜİK, 2015). Additionally, prevalence of ASD was approximately 1 in 68 children in communities across the United States in 2012 (Center for Disease Control and Prevention, 2016). Although frequencies of ASD almost depend on the diagnostic criteria changing according to the clinical studies, it is estimated that the number of individuals with ASD has approached to %1 of population of the world (American Psychiatric Association, 2013).

As indicated in the background of the study part, these individuals have difficulties in expressing language. When they are not able to express themselves, they perform several atypical or challenging behaviors (Frea et al., 2001). In order to overcome this problem, several methods are suggested. One of these methods is to use mobile technologies as an Alternative and Augmentative Communication tool (Logan et al., 2017; Lorah et al., 2015; Mirenda, 2001, 2003). In this regard, the first problem is that there is a lack of literature regarding the features of contextually designed mobile applications acting as Alternative and Augmentative Communication in the special education field.

The second problem is related to the limited number of mobile applications designed for individuals with ASD or communication impairments. As emphasized in the literature, there is a huge diversity among the individuals with special needs. In this regard, there is not enough touchscreen-based mobile applications that could meet the demand of such diversity. Especially, the number of mobile applications designed to promote functional communication in Turkish context are less than it should be.

The third problem is that there are few studies reporting to the design, development and implementation procedure of the mobile applications designed for individuals with ASD. In this sense, current study also tries to understand concerns of both special education teachers and academicians about the design of AAC applications running on touch-screen based devices.

1.3. The Purpose of the Study

The main purpose of this study is to investigate the design, development and evaluation of a mobile application specified for the communication needs of individuals with communication impairments. It aims to combine theory and practice in the designing process of the application. At the end of this process, it is expected to reveal design principles of high-tech AAC systems and to provide a tangible example of a high-tech AAC application. Moreover, it is intended to test the effectiveness of the developed application on functional communication skills of the target group. In doing so, it is also examined how individuals with ASD make simple and multi-step requests for a desired object by using the proposed application.

1.4. The Significance of the Study

Recent technological advancements on portable tablet computers and cell phones give chance to stakeholders for adapting such devices as aided AAC (An et al., 2017; Lorah et al., 2015; Mirenda, 2003; Moffatt et al., 2017; Schlosser et al., 2016; Wojciechowski & Al-Musawi, 2017). These devices provide several benefits for users, parents and educators. Firstly, they can be modified to fulfill the requirements of individuals with ASD or any communication impairments (Schlosser & Koul, 2015). Secondly, using a specific device might stigmatize the users and accordingly cause ethical problems. However, specified tablet computers are more socially acceptable and less stigmatized for the ones who use them (Lorah et al., 2015). Furthermore, teachers, parents and researchers, and caregivers can access and use them easily. As a result, due to the recent technological advancements on portable devices and approved features of such technologies in the society, it has become a requirement to investigate the use of such devices (Lorah et al., 2015) to understand how they facilitate functional communication skills of individuals with ASD and to reveal the design principles of mobile applications for that purpose.

There is a variety of AAC mobile applications in the market currently. Autism Speaks, for example, which is a leading organization about autism, shares various AAC applications on its website such as “GoTalk NOW” and “Aacorn”. In the literature, the effect of such kind of AAC applications on functional communication skills of individuals with communication impairments (Alzrayer, Banda, & Koul, 2017; An et al., 2017; Genc-Tosun & Kurt, 2017b; Nepo, Tincani, Axelrod, & Meszaros, 2017; Wojciechowski & Al-Musawi, 2017) was emphasized frequently. However, although the number of AAC technologies and related research has increased rapidly, there is not a valid AAC tool developed according to characteristics of individuals with ASD and cultural concerns of Turkish people (Genç-Tosun & Kurt, 2017a) and not enough empirical evidence about communication skills gathered in Turkey. Furthermore, almost all of the studies to date have focused on how to enhance communication skills of individuals with ASD. However, it is also crucial to consider both design principles of AAC applications and instructional methods (Mirenda, 2003). In this regard, current study is expected to be a pioneer in the field since it includes both design process and validation of a AAC application in Turkish context.

1.5. Research Questions

The current study focuses on two research questions and a sub question.

Research Question 1: What are the teachers' opinion towards the use of mobile technologies in special education?

Research Question 2: What are the design principles of mobile application designed for communication needs of individuals with ASD based on the subject-matter experts' considerations?

Research Question 3: How effective is the mobile application in functional communication for individuals with ASD?

Sub-question 3.1: How effective is the mobile application in requesting a desired object for individuals with ASD?

1.6. Definitions of Terms

In this part, the terms frequently referred in the present study were defined. While defining the terms, the operational definition technique is used to clarify their meanings.

Alternative and Augmentative Communication (AAC): A group of intervention methods that involve multiple modalities to improve communication skills of individuals with communication impairments (Romski & Sevcik, 2005).

Autism Spectrum Disorders (ASD): A special type of neurodevelopmental disorders that covers (1) deficits in social communication and interaction, and (2) presence of atypical behaviors (American Psychiatric Association, 2013).

Communication Impairments: A group of deficits in expressive and receptive language.

Engelleri Birlikte Aşalım (EBA): A touchscreen-based mobile application that specifically run on tablet computers and aims to improve communication skills of individuals with communication impairments.

Functional Communication: A group of acts by which individuals express their needs and feelings in a way other people can understand. The present study includes three acts to refer the functional communication which are “hold to tablet”, “approach the communication partner”, and “use the tablet to express needs”.

Picture Exchange Communication System (PECS): A low-tech AAC system that was introduced by Bondy and Frost (1994) and aims to improve functional communication through picture exchange.

Requesting: A behavior that children with communication impairments perform to express their needs by using the EBA application on the tablet.

Speech Generating Devices (SGDs): A high-tech AAC system that has speech generating features.

Voice Output Communication Aids (VOCAs): A special type of SGD by which individuals with communication impairments express their needs.

Operational Demand: Ability to operate SGDs.

1.7. Organization of the Study

In current study, there are five chapters which are introduction, literature review, methodology, results, and discussion and conclusion. The justification of the study was presented at the introduction section. In doing so, firstly the background of the study was presented to make readers familiar to the field. Then, the problem statement, purpose of the study, and the significance of the study were provided. After that, research questions under investigation were also briefly introduced. Finally, in the definition of terms part the meanings of the terms were presented in detail.

The second chapter, literature review, covers the following main topics functional communication, alternative and augmentative communication, and design based research. These topics were detailed with several subtopics by summarizing related studies in the literature. The design based research concepts were also detailed in this chapter, because it is a complicated methodology including multiple designs and in order not to leave any gap in the methodology chapter. At the end of the chapter implication of the related studies were also clarified briefly.

The third chapter, methodology, details the research design of current study. It starts with introduction, purpose of study, research questions, design of the study, summary of the design, and justification of current study in design based research framework. Because design based research is an ongoing process to which multiple research methods are embedded, and includes analysis, design, development and evaluation cycles to provide an adequate answer for a real-life problem, it would be difficult for readers to follow the whole process. Therefore, at the beginning of this chapter the summary of research design was presented so that readers become familiar with the research method. Then, the detail of analysis, prototyping, and evaluation phases were presented at the title of "current study at the design based research framework."

The forth chapter, results, were organized within five titles: introduction, data related to the design principles of EBA, functional communication data, requesting data, and refinements on design principles after the implementation of EBA. Firstly, after brief introduction to the results chapter, both design principles and the improvement process of the EBA were detailed. First, the initial prototype of the EBA was introduced. Then, the focus group analysis results were presented. Based on the focus group analysis results, the first iteration of the EBA was illustrated and thereby the second prototype were presented with design concerns. After that, the first expert review results were provided. The second iteration of the EBA and refinements on design principles followed the previous part. Once again, the last expert review analysis results were presented. The final iteration of the EBA was illustrated with design concerns and final improvements on the EBA. At the end of this part, both design concerns and ultimate version of EBA were summarized. Secondly, functional communication data were presented for each participant one by one. Thirdly, requesting data related to the functional communication were presented for each participant. Finally, after the implementation of the EBA the refinements on the design principles of the EBA were provided.

CHAPTER 2

LITERATURE REVIEW

This chapter involves the elaboration of relevant literature related to the research questions under investigation and methodology being employed in the current study. Firstly, an introduction was made to the Autism Spectrum Disorders and characteristics of individuals with ASD. Secondly, the term, functional communication, was determined in the light of relevant literature. Thirdly, alternative and augmentative communication was detailed by elaborating multiple modes of communication, effectiveness of AAC, comparative effectiveness of AAC, and design specification of AAC.

2.1. Neurodevelopmental Disorders

Neurodevelopmental disorders are a set of disorders that are seen in the beginning of the life and affect the personal, social, academic, and professional life of individuals (American Psychiatric Association, 2013). In the Diagnostic and Statistical Manual of Mental Disorders, fifth edition, (DSM-V-TR), six types of disorders were grouped under neurodevelopmental disorders, which are intellectual disability, communication disorders, autism spectrum disorders, attention-deficit or hyperactivity disorder, neurodevelopmental motor disorders, and specific learning disorders. These disorders co-occur in many times; for example, communication disorders or intellectual disability may accompany to the autism spectrum disorders (American Psychiatric Association, 2013).

2.2. Autism Spectrum Disorders (ASDs)

The concept of autism was first introduced by Leo Kanner in 1943. He observed a group of unordinary children and remarked that they were ignoring or disregarding the stimulus coming from outside. This innate inability of relatedness to the situations called as “extreme autistic aloneness” (Kanner, 1943). The concept was then detailed and expanded with further clinical studies and named as Pervasive Developmental Disorders (PDD) at the DSM-IV-TR, and finalized at the DSM-V-TR in the name of Autism Spectrum Disorders (ASD). Accordingly, it is a type of “neurodevelopmental disorders characterized by impairments in social reciprocity, atypical communication, and repetitive behavior” (Hyman & Levy, 2013, p.35). There is no certain risk group in ASD (Wojciechowski & Al-Musawi, 2017), it can be seen at any people with different backgrounds, races, cultures, socioeconomic and educational status. The reason why the “spectrum” expression is preferred in the name is the manifestation of the disorder depends on a verity of factors (American Psychiatric Association, 2013).

2.2.1. Diagnostic Criteria of ASD

There are five diagnostics criteria of ASD presented at DSM-V-TR (American Psychiatric Association, 2013). The first criterion is the absence of *social communication and interaction*. This criterion involves three deficits in social-emotional reciprocity, nonverbal communication acts, and developing healthy relationships. The second criterion is the presence of *atypical behaviors*; in other words, “restricted, repetitive patterns of behaviors, interests, or activities” (p.50). These atypical behaviors can be manifested by four symptoms which are “*stereotyped or repetitive motor movements, insistence on shameless and inflexible adherence to routines, highly restricted and fixated interests that are abnormal in intensity or focus, and hyperactivity to sensory input or unusual interest in in sensory aspect of environment*” (p.50). According to DSM-V-TR, in order to diagnose a person with ASD, s/he need to possess at least two of above-mentioned symptoms. The third criterion is that these symptoms must be seen at the *early development period* of patients and not be triggered by an external factor like learning strategies. The forth criterion is the remarkable impairments in personal, social, and occupational life of the person. The final criterion is that the symptoms of intellectual disability, developmental delay and ASD might be comorbid. In such a case, social communication level of the patients need to be less than general developmental level. The ones who have deficits in social communication but not meet other ASD symptoms are evaluated in communication impairments (American Psychiatric Association, 2013).

2.2.2. Diagnostic Categories of ASD

Five diagnostic criteria of the ASD were explained above. First two criteria are the essential features in ASD. These features are need to be observed at early development of the children and must not be explained with another disorder (American Psychiatric Association, 2013).

Based on the severity level, which is determined by the combination of the number of symptoms, the early language development, and cognitive abilities (Hyman & Levy, 2013), three groups of ASD were presented at the DSM-V-TR. These diagnostic categories are autistic disorder (autism), Asperger’s disorder, and pervasive developmental disorder not otherwise specified (PDD-NOS, atypical autism) (American Psychiatric Association, 2013).

Autistic disorder or more widely known as *autism* possesses the highest severity level among the other categories. Individuals with *autism* are diagnosed with significance deficits in social interaction and communication (Hyman & Levy, 2013). Intellectual disability sometimes may be co-morbid with this category of ASD as well. The second category, *Asperger’s Disorder*, on the other hand, has several milder social challenges. Individuals with Asperger’ Disorder are generally diagnosed when the social demands of their life are apparent (Hyman & Levy, 2013). Finally, diagnosis of *PDD-NOS* is used once the distribution of symptoms of ASD do not meet the requirements of the other categories of ASD (Hyman & Levy, 2013). This disorder’s severity level is also low than autism.

2.2.3. Characteristics of Individuals with ASD

The fundamental diagnostic criteria of ASD are deficits in social communication and interactions and presence of abnormal behaviors (American Psychiatric Association, 2013). However, almost each child in ASD is different than others, but indeed they generally share common characteristics in impairments in social reciprocity, and development of atypical communication and behaviors (Hyman & Levy, 2013; Schultz, 2005; Warren et al., 2011).

Firstly, impairments in social reciprocity imply that children with ASD have difficulties in understanding the feelings of others (Hyman & Levy, 2013). It is expected from a typically developing child to make social interactions with other children. However, children with ASD do not initiate a joint attention behavior, make empathy, worry about distress and make social interactions (Travis, Sigman, & Ruskin, 2001). In a conversation, typically developing children generally look at the eyes of communication partner, but children with ASD do not make eye-contact, instead they focus on mouths (Klin et al., 2002). One important point about the social reciprocity is that these children sometimes be highly sensitive certain situations and persons (Hyman & Levy, 2013).

Secondly, delay in language and communication development is a serious problem for children with ASD, which is apparent in the beginning of their life (Mitchell et al., 2006). This problem brings about deficits in expressive and receptive language skills later on. Furthermore, they have also difficulties in giving meanings to the nonverbal communication behaviors of communication partners. For example, they suffer from inability of discriminating and recognizing the faces since they do not pay attention to the eyes (Dawson, Webb, & McPartland, 2005; Schultz, 2005). If an appropriate intervention is not given, nonverbal communication behaviors might be problematic for these children, even if they develop conversational language skills (Hyman & Levy, 2013).

Finally, atypical or abnormal behaviors are commonly seen at individuals with ASD. These behaviors are almost repetitive, restricted (American Psychiatric Association,

2013) stereotyped, and self-injured (Hyman & Levy, 2013). They strictly adhere certain routines or objects in their daily life (Hyman & Levy, 2013). This might be a ball with red color or a brand of the chocolate they preferred. They focus on a certain part of an object, instead of interesting it as a whole.

2.3. Education and Training for Individuals with ASD

In order to foster language and communication development and get rid of atypical behaviors, early diagnosis of ASD is so vital. After the diagnosis of ASD, a treatment procedure should be managed according to individualized educational program (IEP) and involve all the stakeholders including families, special education teachers, caregivers and speech language pathologists. Different treatment approaches are used in ASD including educational and behavioral approaches, language and social skills interventions, and medication.

2.3.1. Educational Approaches

Educational approaches are started to provide at preschool time. These approaches utilize different instructional strategies including use of reinforcement to teach spontaneous communication and specific skills (Hyman & Levy, 2013), incidental learning (Mesibov, Shea, & Schopler, 2004), and structured teaching (Mesibov et al., 2004; Schopler, 1994). Before starting the treatment, needs of each child should be revealed. Based on the characteristics and cognitive abilities of the child an appropriate learning environment needs to be provided. Although children with autism likely involved in special education classes, children with Asperger's Disorder and PDD-NOS participate inclusive settings (White, Scahill, Klin, Koenig, & Volkmar, 2007).

2.3.1.1. TEACCH Model

An important educational program utilized in the treatment of children with ASD or communication impairments is TEACCH (Treatment and Education of Autistic and related Communication Handicapped Children). The program was first introduced by Eric Schopler in 1972 at the University of North Carolina (Schopler, 1994). It basically focuses on the diagnostic features of the ASD, and attempts to provide solutions for its impairments in a "structured teaching" procedure (Schopler, 1994). This procedure is designed based on the characteristics of the children with ASD (Mesibov & Shea, 2010), which is called "Culture of Autism" (Mesibov et al., 2004). The program does not aim to minimize merely abnormal behaviors, but improves the communication and social interaction (Panerai, Ferrante, & Zingale, 2002; Tutt, Powell, & Thornton, 2006). To sum up, TEACCH provides a structured environment in which children with ASD participate certain individualized activities and requires active participation of both parents and professionals.

2.3.2. Behavioral Approaches

Treatments including behavioral approaches are based on the principles of behaviorist psychology, especially operant condition. Applied Behavior Analysis (ABA), Developmental-Individual Difference-Relationship Based Model (DIR model), Relationship Development Intervention are some of these approaches (Hyman & Levy, 2013).

2.3.2.1. Applied Behavior Analysis (ABA)

Applied Behavior Analysis (ABA) is a "self-examining, self-evaluating, discovery-oriented research produce for studying behavior" (Baer, Wolf, & Risley, 1968, p.91). ABA focuses on socially important behaviors and deals with variables related such behavior (Baer et al., 1968). In this regard, the behavior under investigation needs to be consistent with the social demands (Wolf, 1978).

ABA is conceptually different than an experimental study in that it must be "applied, behavioral, and analytic" (Baer et al., 1968, p.92). Firstly, the term *applied* refers to importance of behavior under investigation for society (Baer et al., 1968; Kazdin, 1977; Wolf, 1978) and the person to whom the treatment is provided (Baer et al., 1968). Secondly, it is *behavioral* because it focuses on a certain measurable behavior of a person. In doing so, it is pragmatic that tries all possible solutions to make something effectively (Baer et al., 1968). Finally, the term *analytic* addresses the reliability of demonstration of behavior change, which can be ensured by a “reversal” or “multiple baselines” techniques (Baer et al., 1968). To sum up, ABA has qualitative characteristic and tries to demonstrate what cause the behavior change in general by manipulating related variables.

The principles of ABA were first employed for behavioral modification of young children autism in 1987 (Lovaas, 1987). An intensive treatment including principles of operant condition was employed by Lovaas (1987). In order to reduce the high rates of aggressive behaviors, different strategies were used, which are ignoring, time-out, alternating socially well-accepted behaviors, and rejecting an undesired behavior by saying loudly ‘no’ (Lovaas, 1987). Consequently, he indicated positive outcomes of intensive treatment on educational and intellectual functioning. This study also proved the treatability of individuals with ASD by using ABA (Warren et al., 2011).

ABA provides a good opportunity to individuals with ASD and intellectual disability (Hyman & Levy, 2013) to improve social language skills and decrease abnormal behaviors. For example, Virués-Ortega, (2010) conducted a meta-analysis of single subject-studies investigating the effect of ABA on intellectual functionally, language skills, and adaptive behaviors of individuals with ASD. The study indicated medium to high positive effect of long-term comprehensive ABA treatments on intellectual functionally, receptive and expressive language development, and some adaptive behaviors including communication, motor and daily living skills, and socialization (Virués-Ortega, 2010).

2.3.3. Communication Trainings

Communication is a complicated issue that includes a variety of interactively working components including hearing, speech, prosody, and language (Stuart, 2013).

However, children with ASD and communication impairments have difficulties in producing verbal speech, prosody, and language skills. It is known that children with ASD can produce words by imitating others, but they have difficulties in spontaneously expressing themselves (An et al., 2017; Romski & Sevcik, 2005; Stuart, 2013; Wojciechowski & Al-Musawi, 2017). In order to promote communication development of such individuals, a variety of treatment methods are used. Before starting the treatment, the abilities of the child are observed by speech language pathologists (SLPs) by using standardized tests. Several interviews with the families and caregivers are accompanied to this process. By means of that, the type of the communication disorder is identified.

SLPs generally manage the treatment procedure based on the deficits identified before. The ultimate goal of the treatment process is to enhance patient's functional outcomes (American Speech-Language-Hearing Association [ASHA], 2016). To do so, SLPs (a) try to provide an appropriate service with respect to the culture and language demand, (b) design, develop, and integrate interventions by considering the individual needs, results of evidence based practice in the field, and opinions of the professionals, (c) make refinements on the treatment service by utilizing previous treatment and AAC performance data, (d) and collaborate with the other stakeholders during the trainings (ASHA, 2016).

Designing an intervention for individuals with severe communication impairments requires teamwork. Experts from different disciplines take place in this process including speech language pathologists, special educators, physical therapists and family members (National Joint Committee for the Communication Needs of Persons With Severe Disabilities (ASHA), 1992). These interventions are important for subjects because they help to establish functional communication abilities so that they (a) meet the daily life needs, (b) have different opportunity in communication modes, and (c) improve social interactions (ASHA, 1992). To do so, ASHA (1992) proposed a list of knowledge, expertise and skills for professionals. The list comprises detailed information about individuals' current developmental stage (cognitive, motor etc.), characteristics (age, diagnose, etc.), modes of communication (aided or unaided), assistive technologies used for communication (SGDs, etc.). Besides, they should have experience in identifying, implementing and managing alternative and augmentative communication tools to enhance functional communication.

Individuals with communication impairments are a potential candidate of alternative and augmentative communication (AAC) treatments (Schlosser & Koul, 2015). These treatments are used to "*prevent delayed communication development and to support communicative participation in daily activities*" (Stuart, 2013, p.341). AAC interventions can be provided by different modalities including sign language, communication boards, Picture Exchange Communication Systems (PECS; Bondy & Frost, 1994), assistive technologies such as Speech Generating Devices (SGDs) and Voice Output Communication Devices (VOCAs). A variety of instructional procedures can be used in AAC; however, the consensus is the use principles of Applied Behavior Analysis (Logan et al., 2017). Because the detail of AAC interventions was elaborated at the following sections, this topic was skipped in this part. To sum up, as long as the number of children with ASD increase, there need for solutions to improve communication skills as well (Hart & Banda, 2009).

2.3.3.1. Language Acquisition for Individuals with ASD

Language can be described as "*an arbitrary code that we use to communicate with one another and speech is an output mode that uses the oral mechanism*" (Romski & Sevcik, 2005, p.176-177). Children form a basis for advanced language skills by acquiring the communication skills like requesting and interacting with the people in the beginning of their life (Light, 1997). Nevertheless, some of those who have communication impairments such as ASD, intellectual and physical disabilities do not improve their language and literacy skills. The verbal language level of individuals with ASD can varied from high speech to its absence (An et al., 2017) depending on their characteristics. These individuals are "*at significant risk in all aspects of their* *development*" (Light & Drager, 2007, p.204). Contrary to a typically developing children, a child with communication impairments face different challenges during the verbal language experience (Light, 1997).

Language is used as a channel by children to express their needs, to make social interactions, and to gain knowledge about their environments (Romski & Sevcik, 2005). It occurs in interrelated contexts that include "*physical, functional, language, social, and cultural*" issues (Light, 1997, p.159). In order to facilitate language learning and to provide better interventions for those who require AAC, parents and trainers should make an effort to understand these contexts better (Light, 1997) in the beginning of children's life; because there is empirical evidence that early language experience influences the later language development of children (Romski & Sevcik, 2005). Additionally, early expressive and receptive language experiences should be integrated into the AAC interventions sessions (Romski & Sevcik, 2005). If these language skills are not taught, they develop alternative communication methods or maladaptive behaviors to express their needs (Frea et al., 2001).

2.3.4. Current Demographics of Individuals with Communication Impairments

Andzik, Schaefer, Nichols, and Chung (2018) surveyed to describe (a) the current characteristics of students with complex communication needs, (b) students' proficiency on communication skills across different disabilities and communication modes, (c) challenging behaviors of students who use different communication modes, (d) types of supports that employed by teachers to improve communication skills of students. They reached 4031 special education teachers who gave information for 15643 students at 50 states of US. Firstly, they categorized the characteristics of students into three groups which are type of disability students have, the number of communication oriented Individualized Education Program (IEP) goals, and communication modes. The most frequently seen disabilities among these students were ASD (23.2%), multiple disabilities (20.2%), and intellectual disability (18.9). The percentage of one to four communication related IEP goals was 95.7. The percentage of other characteristic, communication mode, varied in the order that vocal speech was 81.7, gestural was 6.9, pictorial was 6.5 and SGD was 4.8. Secondly, in the vocal speech mode of the communication, the proficiency level of students with ASD was 55.6, intellectual disability and autism was 32.7, and speech and language impairment was 56.5. In the gestural mode of the communication, the proficiency level of students with ASD was 4.1, intellectual disability and autism was 2.5, and speech and language impairment was 4.3. In the pictorial mode of the communication, proficiency level of students with ASD was 24.5, intellectual disability and autism was 12.9, and speech and language impairment was12.5. In the SGD mode of communication, proficiency level of students with ASD was 63.2, intellectual disability and autism was 38.5, and speech and language impairment was 0. Thirdly, researchers categorized seven challenging behaviors that would be seen on the students. Among these behaviors, researchers reported the percentage of off-task behavior for students using vocal speech mode as 59.3, using gestural mode as 54.6, using pictorial mode as 70.8, and using SGD 48.8. Verbal aggression level was 21.9 for vocal speech mode, 26.4 for gestural mode, 42.1 for pictorial mode, and 20.8 for SDG mode. Physical aggression level was 13.3 for vocal speech mode, 23.8 for gestural mode, 35.8 for pictorial mode, and 20.9 for SDG mode. Finally, the research reported to the level of support to communication skills of students. Accordingly, special education teachers informed the need for instruction with speech language pathologists in the class, and embedded communication training throughout the students' life.

2.3.5. Medical Support

There is no certain medicine that improves the core deficits of ASD (Hyman & Levy, 2013). However, medicine can be evaluated as a part of whole treatment process. Stimulant medications, selective serotonin reuptake inhibitors, atypical neuroleptics, and mood stabilizers are some groups of the medicines frequently used in ASD (Hyman & Levy, 2013).

2.4. Use of Technology for Educational Purposes in Special Education Field

Educational technology applications have become more widespread in different learning settings to engage students with learning activities. They have potential to open new channels for teaching and learning experience of learners. Additionally, it may provide equality in educational opportunities for individuals with special needs. Although the use of information and communication technologies (ICT) is not new in the special education field, the interest to such technologies have increased in recent years due to the facilities they provided (Tsiopela & Jimoyiannis, 2017).

The use of ICT in special education requires a comprehensive understanding of the arguments of the different disciplines including special education and educational technology (Tsiopela & Jimoyiannis, 2017) and the collaboration of different disciplines (Odom et al., 2015; Porayska-Pomsta et al., 2012) with respect to the problem situation. Although there are similarities between educational activities in the early elementary school period and the special education, there is still need several adaptations on the activities due to the diversity in abilities, skills and diagnosis of children with special needs (Fernández-López, Rodríguez-Fórtiz, Rodríguez-Almendros, & Martínez-Segura, 2013). The adaptation of ICT tools in the field was also essential issue due to the several factors including (a) need for effective interventions, (b) their attractiveness for individuals with special needs, and (c) their cost efficiency (Tsiopela & Jimoyiannis, 2017).

Odom et al., (2015) examined the literature focusing on the use of technology in special education settings for students with ASD at high schools. They organized their investigation based on a conceptional framework named CSESA that aims to explain variables having influence on the use of the technology for individuals with ASD. The technology conceptual framework was based on the principles of both Persuasion Theory and Human Activity Assistive Technology Model (HAAT: Cook & Hussey, 2008). Accordingly, the framework consists of four components including human, activity, technology, and context. Human factor refers to the all the stakeholders of problem situation and can be described as users. Families, professionals, individuals with ASD, and special education teachers might be potential user in this framework. The activity and the technology factors are intrinsically interrelated in the framework. While the technology addresses to the equipment or applications being used to make refinements on the deficits of individual with ASD, the implementation of the technology refers to the activity components. Finally, the above mentioned three components occur in a context where the user generally active. Homes, schools and communities are the subcomponents of the context. The intersection of human, technology, and activity components account for the use of technology for individuals with ASD. Any source out of this framework may cause ill-structured explanation for technology use (Odom et al., 2015). Consequently, positive outcomes were reported by Odom et al., (2015) about the use of technology for adolescents with ASD.

Liu, Wu, and Chen (2013) reviewed the literature between 2008 and 2012 to understand the use of technology in special education. They focused on two dimensions including methodological concerns and the type of technology being adapted in the field. Most of the studies they accessed were experimental study focusing on the effectiveness of technology on a predetermined learning outcome. According to their analysis results, computer-assisted technologies such as web-based mentoring and computer games were the most frequently preferred technologies in these years. Specific educational software and mobile technologies accompanied to these technologies. In recent years, on the other hand, mobile technologies have been reported as an effective assistive technology in the field to promote learners' literacy skills (Mims, Stanger, Sears, & White, 2018; Rivera, Hudson, Weiss, & Zambone, 2017), daily living skills (Meister & Salls, 2015), communication skills (Alzrayer et al., 2017; An et al., 2017; Genc-Tosun & Kurt, 2017; Moffatt, Pourshahid, & Baecker, 2017; Nepo et al., 2017), language skills (Rodríguez & Cumming, 2017; Wojciechowski & Al-Musawi, 2017), and learning engagement (Wiley, Cameron, Gulati, & Hogg, 2016). The overall results in the literature indicated that mobile technologies are promising tools to support individuals with special needs (Cumming & Draper Rodríguez, 2017b).

2.4.1. Mobile Technologies for Lifelong Learning

The term lifelong learning addresses to the knowledge acquisition process of learners at any-time and in anywhere. It is regarded as both collaborative and situated activity, which means that learners experience with the learning activities whenever they want and get educational support from the communities to which they linked their beliefs and social lives (Sharples, 2000).

Technology serves a good opportunity to promote lifelong learning by means of providing instant solutions for the problems learners faced in their daily routines, and making easier to link learners with any community in the world. However, there need several abilities that would be attributed to the technology to foster such learning. According to Sharples (2000) these features might be categorized as highly portable, individual, unobtrusive, available anywhere, adaptable to new situations in which learner gain new skills, persistent, useful, and intuitive. Briefly, the technological tool need to be;

- highly portable, it should be mobile so that the user can be able to access the learning material whenever they want.
- individual, Personalized learning makes the learning more engaging for students. Thus, the tool should be customized depending on the characteristics of the learners.
- unobtrusive: it should not obtrusive on the situations while capturing situations and retrieving knowledge.
- available: it should give opportunity to communicate with peers, teachers, and experts.

- adaptable: it should be adaptable to the newly acquired skills of the learners.
- persistent: it should provide opportunity to previously acquired knowledge and stored resources throughout the lifetime.
- useful: it should be appropriate to the learners needs.
- intuitive: without previous experience, it should be operated by the learners.

By default features of mobile devices make them more favorable in lifelong learning. In this regard, these devices are (a) *portable* to reach learning material in anytime and anywhere, (b) *individual*, users can personalize them according to their needs, (c) *unobtrusive*, they are well-accepted in the society, (d) more *available* in the society. Additionally, by providing appropriate applications, which are *adaptable, persistent, useful and intuitive*, these technologies might promote lifelong learning.

2.4.2. Mobile-Devices Based Instruction

Mobile devices are indispensable part of the modern societies and are providing new dimensions in knowledge acquisition (Traxler, 2007). Because of their core features, mobile devices may provide an alternative basis for lifelong learning activities. In this regard, the early definition of the mobile learning had focused on different dimensions in education such as "*spontaneous, portable, personal, situated; informal, unobtrusive, ubiquitous and disruptive*" (Kukulska-Hulme & Traxler, 2005, p.42). It provides a flexible learning environment in which learners access the information in anytime and anywhere (Fernández-López et al., 2013; Kukulska-Hulme & Traxler, 2005; Motiwalla, 2007), which encourages families and professionals to take part in the learning process, and makes learners more social in learning activities (Fernández-López et al., 2013).

While defining the mobile learning, it is crucial to ask the right questions. Technical infrastructure of mobile devices, for example, might be a starting point in designing instruction (Motiwalla, 2007). However, instead of merely focusing device capabilities, we need to associate such capabilities with pedagogical features of the learning (Traxler, 2007). By means of that, learners engage in learning activities to foster their learning (Fernández-López et al., 2013; Wu et al., 2012). Additionally, these activities should be specialized according to pedagogical functions of different theoretical orientations like constructivism (Motiwalla, 2007). Although the effectiveness of mobile learning was emphasized many times in the literature (Wu et al., 2012), however, Martin and Ertzberger (2013) found that computer based instruction is better than mobile instruction in terms of performance scores of learners. But, they also found that mobile learning technologies contributed students to engage in authentic and informal learning activities (Martin & Ertzberger, 2013).

2.4.3. Mobile Learning in Special Education

Due to the several disabilities, children with special needs have difficulties in learning. Most of the special educational program basically focus on the decrease on problem behaviors, improvement on communication and social interaction, and daily living skills (Fernández-López et al., 2013). In this regard, mobile devices have been adapted as an assistive technology in teaching and learning activities in special education. However, mobile learning applications is still questionable in special education because there are still several concerns regarding how individuals with special needs operate the mobile devices for educational purposes (Mohd Yusof, Daniel, Low, & Ab. Aziz, 2014). Therefore, they need to be usable and flexible to integrate them into special education curricula effectively (Campigotto, McEwen, & Demmans Epp, 2013).

Several mobile applications have been tested in the literature in terms of different learning outcomes. Fernández-López et al., (2013), for example, developed a mobile application named *Picaa* running on IOS devices to investigate how the application promote the development of learning skills and whether the activities presented in the application suitable for learning purposes of individuals with special needs. The application offered educational activities including exploration, puzzle, match-up, and sorting. Additionally, it provided opportunity to the educators to make it personalized based on the individual needs of the children. They conducted a pre-experimental study with 39 children with special needs. They reached the conclusion that the *Picaa* is a good tool to improve several educational skills in language and math and to provide an alternative way in communication as a AAC system.

Campigotto et al., (2013) also investigated how iOS devices and specifically MyVoice application effect the motivation and the attention of students with special needs. They also examined the factors having influence on the integration of such devices into special education classrooms. The study reported positive outcomes in terms of motivation and attention depending on the ease of the tasks being completed by the students and spontaneity of the applications on the devices. The study also indicated that the successful integration of applications and devices into special education classrooms depends on whether they meet the needs of students throughout the learning process or not.

2.4.4. Use of Mobile Devices for Educational Purposes for Individuals with ASD

Mobile devices along with suitable applications provide a good opportunity for formal and informal learning activities in special education (Ismaili & Ibrahimi, 2017). There are a variety of assistive applications that are used by individuals with ASD for different purposes in the field. They might be programmed (a) to help children to open a new communication channel, reduce distraction and provide an individualized learning environment, and (b) to assist practitioners to prepare learning activities for students which are regarded always as time-consuming, and to keep the log files of the students for the further investigations (Tsiopela & Jimoyiannis, 2017). Furthermore, they give opportunity to engage users with the target behaviors, to monitor users, and to teach certain skills important to sustain their life (Odom et al., 2015).

Different instructional strategies can be employed in designing mobile instructions for individuals with ASD. Meister and Salls (2015), for example, design an instruction based on the arguments of social learning theory proposed by Bandura (1977). They prepared a step-by-step video material with an intervention aiming to teach several self-care and daily living skills. Eight students with ASD who were between 7.5 and 13.5 years participated to the study. They conducted 49 video modeling sessions with iPad devices during the six-weeks intervention period. Accordingly, they come up with the conclusion that video-modeling technique with mobile devices is helpful to teach daily living skills for individuals with ASD.

Communication impairments and social reciprocity are the foremost diagnostic criteria of ASD (American Psychiatric Association, 2013) and are major obstacles in related individuals' education. Therefore, most of the treatment approaches focus on these deficits. The arguments of behaviorist psychology are frequently referenced strategy being adapted in these approaches. In this regard, mobile devices are also used in these approaches to teach communication skills. A variety researchers (Alzrayer et al., 2017; An et al., 2017; Genc-Tosun & Kurt, 2017; Moffatt et al., 2017; Nepo et al., 2017) have reported positive outcomes in functional communication skills of individuals with ASD by using mobile applications within a communication treatment. The applications designed for communication needs of such individuals offer several functions to improve a target impairment. However, these functionalities might be inadequate without considering non-functional characteristics of applications such as usability of applications, flexibility of the system, and portability (Chung & do Prado Leite, 2009). It is also important to consider the personalization of such technologies due to the diversity in characteristics of individuals with ASD (Fernández-López et al., 2013; Porayska-Pomsta et al., 2012). Therefore, in addition to the functionality of the mobile learning applications, their non-functional characteristics was also need to be considered while designing mobile applications.

2.5. Theoretical Orientations about Effective Artifact Design

The design issues of artifacts are an important focus of many researchers in human computer interaction field. There are two side of the effective and graceful interaction with computers. One is about effective designs addressing a special purpose (Norman, 1988), which is structured by the "designers' intention". The other one is about graceful designs having purposes (Suhman, 1987), that is providing "intelligent artifacts" which are capable of understanding users' intentions by itself.

According to Norman (1988), people generally blame themselves when they faced an unexpected situation while using technology because of their past experience. At the backside of "guilty feeling", however, there are generally many reasons that can be able to explain human behavior. Norman takes people as the explanatory creatures, and explains the psychological roots of blame by focusing on "learned helplessness" and "thought helplessness". Due to the human nature, thought and explanation, he proposes seven stages of action by which people do something. Although it is not a requirement to follow each stage gradually, they can explain the behavior we interacted directly with physical world or in our case new technologies. Followings are the stages emphasized by Norman (1988): (1) Forming the goal, (2) Forming the intention, (3) Specifying the action, (4) Executing the action, (5) Perceiving the state of the world, (6) Interpreting the state of the world, (7) Evaluating the outcome. What makes these stages important for human computer interaction is that they cover the basic criteria to bridge "Gulf of Execution" and "Gulf of Evaluation". In other words, by asking appropriate questions according to "seven stages", designers can provide effective solutions for technologies so that users can be able to use such technology easily without blaming themselves.

After the emergence of the cognitive science and the idea of implementing human mind to the other objects around us, an improvement regarding "intelligent artifacts" was observed in the field. Through the implementation of "information processing theory" to computer modeling, cognitive science ensured its validity. Since the computational artifacts possess properties like "reactive" (computers react users each actions), "linguistic" (controlling computer is becoming more linguistic than mechanistic) and “opaque” (not clear what is going on computer for everyone) just like the mind, they can be interpreted as the “self-explanatory artifacts”. That requires developing artifacts that can be able to explain themselves. In other words, instead of understanding designers’ intention on device (as defended by Norman), they should understand users’ intention then react rationally (Suchman, 1987).

The arguments of both Norman (1988) and Suchman (1987) address to the usable artifacts in different point of views. But the consensus is on the user centered designs that may refer to the needs of user concurrently. From this point of view while designing instructional material, the design of the material need to be considered, because unusable design may increase the extraneous cognitive load (Mayer, 2001) and may affect adversely the learning.

2.5.1. Usability

The term usability refers “*to the extent to which a product can be used by specified users to achieve specified goals with effectiveness, efficiency and satisfaction in a specified context of use*” (ISO 9241-11, 1988). The definition emphasizes three important concepts which are effectiveness, efficiency, and satisfaction. According to Çağıltay, (2011) effectiveness can be measured whether a task is successfully completed or not. Additionally, the efficiency refers to the time when the user completed a specific task. Finally, the satisfaction is related to the positive or negative perception after experiencing a product. There are also several parameters that are frequently used to identify the usability of a product. According to Nielsen (1993), for example, learnability and memorability of the product, and the error rate while using the product are the qualities that should be on the usable product.

2.5.2. Participatory Design

Usability studies are conducted by the developers to understand children’s responses toward a certain product (Light et al., 2007). Children experience with the product by completing several tasks for a while. By means of that, designers and developers have opportunity to revise the product before making it available on the market. However, during this process children merely response the existing design, do not contribute to the initial design specifications (Light et al., 2007). Alternatively, participatory design (Muller, 1991) is suggested to improve end-users' participation to the design process. As noted by Druin et al., (1998), end-users take part in the initial stages of product design by working with researchers on low-tech prototypes collaboratively. This method helps researchers to discover new technology possibilities (Druin et al., 1998) and to approach the issue from a different viewpoint. Since the user directly takes part in the design process, it reduces the cognitive demands of tasks (Light et al., 2007). It is clear that there should be a variety of people in the design process of AAC systems involving communication impairments, communication partners, parents and service providers (Light et al., 2007). By means of that, all the stakeholders of the problem have voice in the design process (Light & Drager, 2002).

2.5.3. Usability of AAC Applications

Most of the usability studies focus on the arguments of cognitive psychology. This requires a comprehensive understanding of memory models proposed by Baddaley (2009). However, there is no clear descriptions of memory models and how information is processed in the mind for individuals with special needs. Therefore, the usability studies in special education may not provide a general pattern, but be suggestive.

There is lack of literature regarding how to design AAC applications for communication needs of individuals with ASD. However, there are lots of studies (Alzrayer, Banda, & Koul, 2017; Genc-Tosun & Kurt, 2017; Hart & Banda, 2009; Mirenda, 2003; Nepo, Tincani, Axelrod, & Meszaros, 2017; Tien, 2008) investigating the effectiveness of AAC applications. To ensure valid design guidelines for such applications, there is also need further studies focusing on effectiveness, satisfaction level, learnability and memorability of AAC systems.

2.6. Functional Communication

American Speech-Language-Hearing Association (ASHA) proposed several guidelines to identify the communication needs of people with severe communication impairments in 1992. The organization also determined the definition of "communication" to meet its requirements. According to them (ASHA, 1992) communication is "*any act by which one person gives to or receives from another person information about that person's needs, desires, perceptions, knowledge, or effective states. Communication may be intentional or unintentional, may involve conventional or unconventional signals, may take linguistic or nonlinguistic forms, and may occur through spoken or other modes*". In addition to that, a variety of philosophical approaches have attempted to explain function of language. Behaviorist approach, for example, considers the language as "verbal behavior" (Skinner, 1957) and explains it through the principles of operant condition process. According to Skinner, (1957) verbal behavior is a "*behavior reinforced through the mediation of other persons' needs and certain refinements*" (p. 2). This definition implies that verbal behavior is produced by speaker and mediated by listener. All the behaviors of both listener and speaker form the "speech episode" in the context (Skinner, 1957). The both definitions of communication indicate that speech is not the sole modality of communication (ASHA, 1992); it can be provided in different ways (Frost & Bondy, 2006) such as sign language and assistive technologies.

According to Skinner (1957), whether it is verbal or nonverbal, a behavior is reinforced and become strength by a desired consequence. In the early language development stage of children, parents "*set up a repertoire of responses in the child by reinforcing many instances of a response*" (Skinner, 1957, p.29). For example, when children start to exhibit a verbal behavior, the setting and people reinforce that behavior. This process continues toward the acquisition of meaningful verbal behavior. If a response of a child is desired, effective reinforcement needs to be provided to add that response to the current repertoire. On the other hand, if a response is desired to remove from the verbal repertoire, the extinction process needs to be established. In conclusion, children attribute a meaning to verbal behavior based on the related responses gathered in the community where children are in (Skinner, 1957).

2.6.1. Verbal Operands and Controlling Variables

Skinner, (1957) described several variables in "Verbal Behavior" in terms of their functions in language acquisition. He named the first type of variable as "mand", in other words "requesting". According to Skinner (1957) "mand" is the first verbal operant "*in which the response is reinforced by a characteristic consequence and is therefore under the functional control of relevant conditions of deprivation or aversive situation*" (p.35-36). For example, a child makes a request for an item and says, "I want ice-cream". In this case the child is taught to give response towards an ice cream by a verbal expression ("I want …"). Therefore "mand" is not a response to a specific stimulus rather it is a response that is under the control of motivational operands (Frost & Bondy, 2006). That is, the rate of requesting for an object depends on whether individuals desire it or not.

The second variable is "tact" or "labeling". In this case, the child gives a verbal response to a nonverbal stimulus (Skinner, 1957). According to Skinner (1957), tact is a verbal operant that is evoked by "a particular object or event or property of an object or event" (p.82). That is, we commonly name or label some objects, events or actions around us and express it via a verbal response. For example, when a child see a car, s/he might say that "Oh! A car."

Other three variables, "Echoic", "textual", and "intraverbal", on the other hand, meet the common point of need for a prior verbal stimulus to a certain response (Skinner, 1957). In "echoic", while the stimulus is auditory, the response is verbal. For example, a parent wants his/her child to repeat what is said when the child is in the initial stage of leaning a new behavior. By this way, the role of imitation was emphasized in language acquisition by Skinner. "Textual" behavior includes the responses toward printed or written stimulus (Skinner, 1957). Verbal operant for pictures, graphics, symbols or letters of a phonetic alphabet can be a textual form of behavior. In echoic and textual behavior, there exist a point-to-point correspondence between response and stimuli (Skinner, 1957). However, it is not possible to assert the same argument for "intraverbal" behavior in that it is controlled by different stimulus. It is a typical verbal response to someone's own verbal verbalization or someone else's verbalization (Frost & Bondy, 2006). Since point-to-point correspondence does not exist, it is a requirement to consider all combinations of auditory-written stimuli and auditory-written responses. Daily conversations and questions people answer consist "intraverbal" behavior in general.

Table 2.1. *Summary of Verbal Operands and Conditional Variables*

Conditional Statement	*Consequences*	*Verbal Operant*	*Example*
State of Deprivation/ Aversive Stimulation	Consequences related to the state of Deprivation/Aversive Stimulation (Direct)	Mand	When the child gets thirsty, s/he says, "*I want a glass of water*". Then his/her mom gives some water.
Aspect of Environment	Educational/Social Consequences	Tact	While walking dawn in the street, a child sees a car, and says, "Look mom! *A car.*" Then his/her mom approves his behavior by saying "yes, it is."
One others Verbal Stimulus	Educational/Social Consequences	Intraverbal	Mom asks her child that "When did you finish your homework?" The child replies "An *hour ago*". Then, his/her mom says, "That's great! We can visit your dad."

Prior Auditory Stimulus	Educational/Social Consequences	Echoic	Mom wants her child the repeat that “The capital city of Turkey is Ankara”. Then the child says, “*The capital city of Turkey is Ankara*”. After that, the mom approves his/her.
Speakers own verbal Stimulus	Consequences related to the state of Deprivation/Aversive Stimulation (Direct)	Autolictic	Mom asks the child “Did you see your dad?” The child replies, “*He is in the garage, I guess*”. Then, mom says “Thanks..."

According to Skinner (1957), presence of a listener is crucial factor to evoke a verbal behavior. It can also be a discriminative stimulus in the setting and called as “audience”. Therefore, an “audience” is “*discriminative stimulus in the presence of which verbal behavior is characteristically reinforced and in the presence of which, it is characteristically strong*” (Skinner, 1957, p.172). For example, in a communication setting, if the listener moves away, then the verbal behavior is lessened. This can be seen at any situation in which the listener is not perceived effectively as well.

One more issue that is attributed to the speaker’s own verbal behavior is “autoclicit”. By means of “autolictic”, speaker describes his/her own verbal behavior. There are several types of “autoclicit” behavior. Firstly, a speaker can imply what would accompany his/her own behavior by saying “I see it is going to snow.” The expressions like “I see…” and “I hear…” take place in this type. Additionally, “autoclicits” illustrates the strength of verbal behavior such as “I guess…”, “I think…”, “I believe” etc. Or occasionally, some expressions “*describe the relation between response and other verbal behavior ’s of listener or speaker, or other circumstances*” (Skinner, 1957, p.316) such as “I agree…” “I predict…” “I must say …”, and so on. The name of verbal operant changes depends on the combination of selected conditional statements and its consequences (see Table 2.1, adapted from Frost & Bondy, 2006).

2.7. Alternative and Augmentative Communication (AAC)

Children with communication impairments may encounter a variety of challenges while experiencing with the spoken language (Light, 1997). They sometimes have to communicate in an unconventional way that is not approved in the society (Romski & Sevcik, 2005). In this regard, AAC systems provide an alternative channel to preclude unconventional ways of communication (Romski & Sevcik, 2005) and to promote existing verbal language (Mirenda, 2003).

The term alternative and augmentative communication is used to describe a group of intervention methods that include multiple modalities to help children to express their needs and to improve their communication skills (Romski & Sevcik, 2005). It involves different methods or tools that promote or replace natural speech (Mirenda, 2003; Moffatt et al., 2017), facilitate overall development progress of children (Romski & Sevcik, 2005), and help to express choices and preferences (Frea et al., 2001). It is promising for individuals in different ages (Ganz et al., 2017) not only for requesting a tangible object, but also requesting a social routine or information (Logan et al., 2017). Briefly, it opens an augmentative speech channel, offers an output mode for communication and language, and provides an intervention strategy for language acquisition (Romski & Sevcik, 2005).

The professional use of AACs began in the mid-20th century. The field has witnessed a variety of developments since 1980s; including improvements on both device capabilities and intelligibility of outputs (Romski & Sevcik, 2005). Nowadays, AAC systems are more portable and accessible due to the recent advancements on mobile technologies (Schlosser et al., 2016). Additionally, the built-in features of mobile devices and various applications available on the market make mobile devices more feasible to improve hearing, writing, communication and life skills of individuals with special needs (Ok, 2018).

2.7.1. Alternative and Augmentative Communication Methods

Based on the criterion of whether any additional equipment is required for communication or not, AAC methods generally divided into two categories: aided and unaided (Alzrayer et al., 2017; Lorah et al., 2015; Mirenda, 2003; Moffatt et al., 2017; Romski & Sevcik, 2005). Unaided AAC (i.e., sign language, gestures) does not require any additional equipment, but aided AAC (i.e., PECS, SGDs) does. In other words, aided AAC requires external aid (Romski & Sevcik, 2005; Schlosser & Sigafoos, 2006) which is beyond the persons' body (Andzik et al., 2018).

Research results directly comparing aided and unaided AAC techniques are mixed. While some of them illustrated aided AAC as easier to learn and use, the others suggested unaided AAC to use (Mirenda, 2003). According to Mirenda (2003), unaided AAC studies commonly focused on receptive and expressive labelling, however aided AAC studies mostly focused on functional communication, especially requesting skills. According to An et al., (2017), on the other hand, they are both suitable to enhance functional communication of individuals with communication impairments.

2.7.1.2. Unaided AAC

As mentioned above, unaided AAC methods do not require any additional equipment for communication. They can be used anytime and anywhere, without requiring an external tool (Moffatt et al., 2017). Having sufficient fine motor skills are a prerequisite to use these methods in communication (Mirenda, 2003).

Different modalities in unaided AAC have been investigated in the literature including simultaneous communication, sign language, and oral instruction for expressive signing, natural speech production, and receptive speech (Schlosser & Sigafoos, 2006). Barrera, Lobato-Barrera, and Sulzer-Azaroff (1980), for example, investigated the comparative effectiveness of three abovementioned unaided methods on expressive language skills. They reached the conclusion that simultaneous communication is better than the other methods. Additionally, simultaneous communication methods were also found superior than the other methods in receptive language skills (Brady & Smouse, 1978).

While evaluating the unaided literature, it is also critical to concern the comorbid effect of instructional strategies employed during the intervention and characteristic of participants. In order to enhance expressive singing acquisition, for example, different instructional strategies are suggested including positive reinforcement, time delay, introduction of words from known to unknown (Schlosser & Sigafoos, 2006).

2.7.1.3. Aided AAC

Aided AAC is required an external equipment or tool. The type of the aided AAC may change depending on the characteristics of selected equipment. Accordingly, there are two types of aided AAC: low-tech and high-tech (Moffatt et al., 2017; Nepo et al., 2017).

2.7.1.3.1. Picture Exchange Communication System (PECS)

Low-tech aided AAC techniques involve external tools for communication. But these tools are almost simple in nature and do not work with electricity (Moffatt et al., 2017), and not require high-level computer literacy skills. Picture Exchange Communication System (Bondy & Frost, 1994, 2001; Frost & Bondy, 2006) is a good example for low-tech aided AAC.

Children with ASD generally encounter difficulties in functional communication skills. In order to teach such skills, different behavioral principles have been applied by researchers so far (Sulzer-Azaroff, Hoffman, Horton, Bondy, & Frost, 2009). As an alternative and augmentative communication method, Bondy & Frost (1994) proposed Picture Exchange Communication System (PECS) for those who have communication impairments and whose functional speech is not on desired level (Hart & Banda, 2009; Mirenda, 2001). It differs from other AAC in that it is not require prerequisite skills and the child initiates learning process through requesting without any external verbal prompt (Hart & Banda, 2009). Unlike other AAC methods, the children do not have to know pointing or matching skills (Lancioni et al., 2007).

The Picture Exchange Communication System (PECS) is a type of low-tech alternative communication method that has its roots from the principles of applied behavior analysis (Bondy & Frost, 1994, 2001; Tien, 2008). PECS can be interpreted as a bridge towards to speech acquisition (Tien, 2008). It, originally, relies on the language acquisition arguments proposed by Skinner (1957) and the fact; autistic children more likely respond a behavior that leads concrete outcomes (Mundy, Sigman, & Kasari, 1990). PECS interventions begins with teaching basic communication skill, requesting, and continues towards to acquisition of commenting (Bondy & Frost, 1994, 2001). Throughout this process principles of behaviorist psychology and different instructional strategies including reinforcement, error correction and generalization are frequently employed (Bondy & Frost, 1994).

Although, it was developed for children with ASD in preschool age, three are different implementation of method in the literature including children with ASD at pre-school age (Lerna, Esposito, Conson, Russo, & Massagli, 2012), at school age (Gordon et al., 2011; Türkbay, Karaman, & Çiyiltepe, 2005), and adults (Stoner et al., 2006). Additionally, it is also suggested for different diagnosis (Mirenda, 2001) involving "*pervasive developmental disorder - not otherwise specified (PDD - NOS), attention-deficit/hyperactivity disorder (ADHD), cerebral palsy, severe or profound mental retardation, developmental delays, severe learning difficulties, severe disabilities*" (Sulzer-Azaroff et al., 2009, p.8).

2.7.1.3.1.1. PECS Phases

The starting point of PECS is to teach requesting to a child. To do so, the trainer needs to identify the desirable objects to which the child likely responds. To do so, a preference assessment needs to be done. In order to know what the child exactly desire, trainer presents some tangible object in front of the child and observe the child for a while. During this process, trainer should not use any verbal prompts including “What would you like”, “Do you wants that/this” (Bondy & Frost, 2001) because of the potential risk that child make connection between the verbal prompt and desired object. It is assumed children are prone to get the most desired object and spent some time with that object. Based on this assumption, a desired object is identified at the end of the reinforce inventory process (preference assessment). PECS intervention is built upon the selected object and aims to teach six interrelated phases; which are how to communicate, distance and persistence, discriminating between pictures, using phrases, answering a direct question, and commenting. Based on the problem situation and structure of tools used for communication, PECS protocols with several modifications used as an instructional strategy (Genç-Tosun & Kurt, 2017a). According to Gevarter et al., (2015) provides promising results in AAC, therefore vocal instructional strategies used in PECS protocols may be applied to the other AAC methods.

***Phase 1**. How to Communicate*

The first phase of PECS includes basic strategies to teach communication. It takes inspiration from the initial communication attempts of typically developing children. In other words, children approach their parents, exhibit a behavior and get positive or negative reactions in the beginning of their life. By means of that, they learn the main logic behind the communication. Likewise, PECS begins with teaching requesting skill without using verbal prompts (Bondy & Frost, 1994, 2001). This process, is planned in the first phase of PECS in an order that child need to approach to communicative partner and receive the previously identified picture into his/her hand to get desired object (outcome).

In order to manage phase 1 activities, there need two essential practitioners in the setting: communicative partner and physical prompter. *Communicative partner* is called as trainer and responds child's appropriate behaviors. *Physical prompter* assists the child to pick up the picture card and receive it to communicative partner's hand. Communicative partner immediately gives the desired outcome to child as soon as the child release the picture card on the partner's hand. This training process called as "exchange". For example, let's suppose that the child selected a chocolate bar as a desired item at the beginning of treatment. Then the following activities are made. First, the communicative partner and the child sit in front of a table face to face. A picture card referring to the desired object is presented in front of the child. The desired object, chocolate bar, is located in in front of the communication partner. It is expected from the child to ask the chocolate. However, in order to get the chocolate, s/he is expected to pick up the picture card and release into trainers' hand. At the beginning, since it could be difficult to act like this, physical promoter, who generally stands behind the child, guides the child to accomplish the expected behavior. This physical guidance can be faded if the child makes progress after several trails. Additionally, it can be noted that when the child releases the picture card correctly, the trainer reinforces child's behavior via gestures and saying something like "You want chocolate" and gives the desired object. At the end of the phase 1, the child expected to take the picture card and give it to the trainer's hand when s/he wants the desired object (Bondy & Frost, 1994).

Phase 2. *Distance and Persistence*

The first phase aims to teach requesting skill by exchanging a picture card and the desired object in a specific setting where communication partner and the child in a specific place. The second phase, on the other hand, aims to extend pre-acquired skill with new challenges. These challenges include attempts like carrying picture card to the trainer who is far away from the child. In this phase, both the distance between child-trainer and child-picture need to be gradually increased to enhance spontaneous communication (Bondy & Frost, 1994). Thus, the main characteristics of second phase is to ensure the exchange process in physical distance. Throughout second phase, the child need to be taught making exchange with different trainers and in different contexts to improve spontaneity. In order to get successful results from the rest of the phases, this phase need to be accomplished successfully.

Phase 3. *Discriminating between Pictures*

Once children accomplished the exchanging process with different trainers and in different settings correctly, the next step of discriminating pictures phase becomes. In this phase, two picture cards with corresponding objects are determined in advance. While one of the picture card brings about a highly-desired outcome, the other one causes non-desired outcome as well. After deciding picture cards and pre-determined consequences, the child is allowed to select one of the picture card in front of him or her. If the child takes the desired object's picture card and puts it to trainer's hand, then s/he gets the desired object. If the child gives the distracter picture card to the trainer, then s/he gets the non-desired item. However, if the child really wants the highly desired item, but s/he does not give the right corresponding picture card to the trainer, this time an error correction procedure is applied to teach discriminating pictures (Bondy & Frost, 2001). Once the child reaches the expected level that is taking the highly-desired item by giving the right picture card to the trainer, two equally desired items are provided to child. In this phase a communication book can be used on which the child can be able to arrange picture cards in an effective way (Bondy & Frost, 1994). Discrimination training continues by increasing the number of desired items and corresponding picture cards on the communication book. At the end of the third phase, the child expected to discriminate 5 or 6 pictures.

Phase 4. *Using Phrases*

Typically developing children assign certain roles to their early verbal prompts. For example, when they say “water”, s/he would either request water or commenting something about water. Their gestures and exclamatory voice tone illustrate us whether they are “requesting" or “commenting” (Bondy & Frost, 2001). However, the situation is a bit complicated for children with ASD in that they do not possess any gestures and verbal prompts (Bondy & Frost, 2001). Therefore, the main purpose of forth phase is to teach “commenting” skill for that children.

Previously children were taught to request a desired item by giving corresponding picture card to the trainer. In this phase, however, the requesting format is altered by adding a new card referring “I want …” phase on the communication book (Bondy & Frost, 1994). The child needs to take the required picture and put it to right-side of “I want …” picture card. By means of that, child learns the requesting skill of communication. Furthermore, in PECS the phrases like “I see”, “I hear” and “It is” are accepted as commenting marks (Bondy & Frost, 2001). Thus, new pictures that represent such phases are added to communication book. The child drags the requesting or commenting picture to a sentence strip on the communication book the express himself or herself. Consequently, in addition to requesting (“I want something”), commenting (“I see ….”, etc.), and the function of communication is also taught to child in this phase (Bondy & Frost, 1994).

***Phase 5**. Answering a direct question*

The main purpose of this phase is to teach answering a question. That is the child is supposed to respond the questing of “What do you want?” that leads the desired item. Because the child has learned the sentence structure at previous phases and the desired item is motivated factor to act, this phase is taught rapidly (Bondy & Frost, 2001). According to Bondy and Frost (2001), time delay procedure is used to encourage child to increase spontaneous requesting in this phase.

***Phrase 6**. Commenting*

In last phase children need to be taught requesting and answering question of “What do you want?”. They learned a variety of picture cards and corresponding desired objects till to last phase. In this phase, trainer adds a new phrase named as “I see” to the communication board. Then, s/he asks “What do you see” by using delay prompting procedure. In other words, while trainer pointing the “I see” picture, s/he ask the question. Additionally, instead of merely using tangible reinforcements (desired items), trainer gives social reinforcement like “Yes, I see a car, too!” (Bondy & Frost, 2001). In addition to the question of “What do you see?”, new questions such as “What do you have?”, “What do you hear?”, etc. are added to the last phase. By means of that children learn labeling and naming objects (Bondy & Frost, 1994). Throughout the process, different opportunities need to be provided to the children so that they maintain the previously acquired communication skills.

2.7.1.3.2. Speech Generating Devices (SGDs)

High-tech AAC techniques involve the use of electronic devices (Moffatt et al., 2017), which are all have information processing capability. They are also known as SGDs or VOCAs (Nepo et al., 2017), which are more preferable than their low-tech counterparts (Lorah et al., 2015). High-tech AAC technologies might be either device dependent or application dependent. Device dependent high-tech AAC technologies are devices that are designed and produced depending on the special needs of individuals. These devices are offered by certain companies and are named by a special brand. Tobii Dynavox i and t series, Vantage, Lingraphica, Tellus Smart, and Gus Communicator can be an example of device dependent aided AAC tools. On the other hand, application dependent AAC technologies are mobile software that are executed under a certain operation system such as Android, Windows, and iOS. These applications are also designed and developed according to special needs of individuals. Contrary to device dependent aided AAC tools, design and development of application dependent aided AAC technologies technically do not require much effort. There are a variety of such applications available on Play Store or App Store as well. For example, SmallTalk, Proloquo2Go, MyTalk Mobile, TalkRocketGo, GoTalkNow, and VocaBeans are frequently used apps in the market.

Application based high-tech aided AAC technologies have become widespread in society since portability and accessibility of mobile devices (e.g., iPad) have increased due to the recent advancements on information technology (Lorah et al., 2015). Contrary to traditional AAC devices, touchscreen based mobile devices are more favorable because they support not only functional communication but also provide several functions that make life quality better (Nepo et al., 2017). Furthermore, they support not only face-to-face communication but also alternative communication ways including e-mailing, telecommunication, and social media (Desch, 2013) in any context (Ganz et al., 2017).

Speech Generating Devices (SGD) or Voice Output Communication Devices (VOCA) are a kind of electronic devices that are capable of generating synthetic or digitized speech output to communicate after touching or pressing an item, icon or any word on its screen (Lorah et al., 2015; Mirenda, 2003). There already exist hundreds of electronic devices and applications being used for that purpose. As a consequence of that they have become more popular and preferable in recent years over other systems (Gevarter et al., 2015).

Mobile devices have been modified as a SGD or VOCA after the introduction of touchscreen-based mobile devices (e.g., iPad). These devices have several features that made them suitable for AAC interventions, which are high data storage, both synthetic and digitized speech generating feature, and sensitive touch-screen. According to McNaughton and Light (2013), these devices provide several benefits for individuals with communication impairments, which are socially acceptable, cost-efficient, easily adaptation, and functionality.

In order to understand the current status and trends of SGD usage in the field, many researchers (Genç-Tosun & Kurt, 2017; Schlosser & Koul, 2015) systematically reviewed the related literature in recent years. Genç-Tosun & Kurt (2017a), for example, reached 26 studies published between 2010 and 2015 based on the criteria including (a) at least a participant must be diagnosed with ASD, (b) single-subject case study methodology must be used, (c) new generation SGDs must be used as an intervention, and (d) the study must be published on a peer-reviewed journal. They evaluated the results from different point of views: participants, settings and implementers, dependent and independent variables, design of the study, results, reliability, generalization of results, and social validity. They reached the result that SGDs was adapted as an AAC tool for individuals between 3 and 23. Among these age groups, the ones who are between 3 and 6 were the frequently preferred groups by researchers. The implementation sessions were conducted at different settings such as home, school and rehabilitation centers. Expressing needs and wants of participants were frequently selected dependent variable by the researchers. In order to teach the target skills and behaviors, mobile devices with speech capabilities and systematic instructions including prompting, interval reinforcements, time delay, error correction, and modeling strategies were used as independent variables. Research results gave insight into the implementation of AAC tools for functional communication. According to Genç-Tosun & Kurt (2017a), to improve the communication needs of individuals with ASD, SGDs provides an effective alternative channel. But it is more logical to explain this effect by the use of appropriate device, application and instructional strategy.

Schlosser and Koul, (2015), on the other hand, approached the subject comprehensively to understand the effectiveness of AAC interventions including speech output, to figure out the gaps in current literature, and to elaborate the future research directions. Accordingly, they reached 26 studies in which speech output technology were used in a treatment package. The ultimate goal of these studies was to improve requesting skills and to decrease the atypical behaviors of individuals with ASD. The results of their review also indicated that there was a shift from single-step requesting towards to conditional and multiple-step requesting in the literature.

Additionally, in order to overcome challenging behaviors of individuals with ASD, there was an increased interest in promoting natural speech production via a treatment package including speech output technology. SGD devices had been used for speech production in early studies, however with the advancements on current mobile technologies; mobile devices and applications were adapted to SGDs (Schlosser & Koul, 2015).

2.7.1.4. The Comparison of Aided and Unaided AAC Techniques

Mirenda (2003) reviewed the AAC literature and discussed the strengths and weakness of both aided and unaided AAC techniques. In this regard, aided techniques were more preferable (Logan et al., 2017) in that they do not need many fine motor skills, are more comprehensible for unfamiliar partners, are easier to use for communication partners. On the other hand, unaided techniques are more favorable because they are portable, not need to carry any additional tool or devices, are not easy to lose, and are not need any additional storage that is limitless. However, when these two techniques are compared, it is possible to compensate weakness of aided AAC techniques through the opportunities offered by new technological devices. Since recent technological developments give chance stakeholders to store a mass of information on a portable device, such weakness can be eliminated. Apart from these, the most important aspect that need to be considered is their effect on functional communication, which need further empirical research. Moreover, whether it is aided or unaided, the success or failure of selected techniques are related to the characteristics of learners, contexts and needs of learners (Beukelman & Mirenda, 1998), instructional approaches, communication partners and needs (Mirenda, 2003). Additionally, interaction effect of both intrinsic factors like motivation and extrinsic factors such as the society where the child grows up has a key role in the failure or success of the selected mode (Light & Drager, 2007).

2.7.1.5. Expressive Language (Requesting Skills)

The foremost goal of the interventions with AAC systems is to help the children to gain the expressive language skills (Light, 1997). In this regard, a variety of AAC interventions have been used to improve expressive language via requesting. In this part, several empirical studies and meta-analysis including different AAC interventions were summarized related to the requesting skills.

2.7.1.5.1. High-tech AAC Interventions

Single step requesting is frequently taught skill in the beginning of functional communication. Systematic reviews have revealed the potential of tablet-based SGDs for enhancing this skill. However, some of social communicative skills such as commenting, asking a question and answering a questing require use of multi-step requesting on tablet-based SGDs. In this regard, Alzrayer et al., (2017) investigated the use of tablet computers for multi-step requesting by individuals with ASD. In doing so, they focused on how participants with communication impairments navigate the tablet with the intention of communication and combine symbols for requesting. They reported the successful use of navigation and symbol combination. An et al., (2017) also tested the effectiveness of a touchscreen based mobile application they developed on simple and multiple requesting skills of individuals with ASD. They followed the first five phases of PECS protocols during the treatment procedure. Participants who received the treatment performed three consecutive correct responses in at least three of the five phases. Researchers concluded that the proposed application with PECS protocols improved requesting skills of individuals with ASD.

As previously emphasized “mand” is a type of verbal operant that involve certain communication acts to make request (Skinner, 1957), which is controlled by motivational factors (Frost & Bondy, 2006). In this regard Lorah et al., (2015) investigated the adaptation of portable hand-held devices (tablet computers, media players etc.) for functional communication. In doing so, they examined peer-reviewed journals published between 2007 and 2014, and analyzed 17 articles. They mainly focused on verbal operands such as mand, tact etc. (Skinner, 1957), teaching strategies, discriminating, comparison of AAC methods, and device preferences. Overall results illustrated higher acquisition of mand repertoire through such devices and user preference. Therefore, they strongly suggested the use of hand-held devices as SGD to teach verbal behavior for individuals with ASD or related disabilities.

There are several studies that focus on multiple communication skills including requesting in the literature. Schepis, Reid, Behrmann, & Sutton (1998), for example, investigated the effect of VOCA along with naturalistic teaching procedures on interpersonal communications of young children with ASD. Four participants aged between 3 and 5 years were selected based on the students' attitudes toward communicative interactions in class. Researchers took several criterions into consideration to select appropriate VOCA device, which are demographic information about participants, classroom staffs' opinions about graphic representations to be used on VOCA, children's current communication techniques (e.g., gestures). The selected VOCA was specialized for "snack" and "play" routines and included the several messages like "I'd like a snack, please", "thank you", "yes", "no", "I need help", etc. Research results indicated that children using VOCA increased their communicative interactions. Furthermore, they also used VOCA for different communication aims like "requesting", "responding to questions", and "commenting". As a result, the study supports the use of VOCA in conjunction with further research regarding more valid child-to-child interactions.

Very few studies have examined the use of high-tech AAC interventions for functional communication in Turkish literate. However, there is a raising interest in the use of touch-screen based mobile devices for functional communication in recent years. In this regard, Genc-Tosun & Kurt (2017b) investigated the effect of an iPad based SGD with an instructional method including time delay, reinforcement, trial and error, and prompting strategies on multi-step requesting. They also concerned about the parents' and teachers' views about the implementation of iPad based SGD. They reached three children between four and five ages based on six inclusion criteria, which are (1) they need be diagnosed with ASD, (2) they do not have adequate functional communication skills, (3) they need adequate motor skills to operate the SGD, (4) they need adequate ability to make selection, (5) they can be able to follow simple directions, and (6) they can be able to exposed visual and verbal stimuli for 5 minutes. In order to understand the effect of intervention, they conducted a single subject study with multiple probe design across participants. The research results indicated that the use of iPad based SGD with an intervention package is effective on multiple-requesting for individuals with ASD. In addition to this result, children also obtained particular skills to operate the iPad for requesting: which are (a) switching on the iPad for use, (b) unlocking the device screen, (c) selecting appropriate category to reach related symbols, (d) scrolling on the page to find the desired symbol, and (e) touching the desired objects' symbol on the screen. The research also indicated that almost all of the parents and teachers have positive opinions about the use of SGDs for requesting, except one parent's negative views about implantation.

High-tech and low-tech aided AAC methods were also compared in terms of communication acquisition and user preferences. Overall findings showed that acquisition of mand (requesting) repertoire with SGDs was quicker than picture exchange and sign language (Lorah et al., 2015). Additionally, those who trained with PECS, increase their verbal repertoire over the time. As a result, they carry corresponding symbols or cards and a communication book with them. Such increasing symbols and cards might become a deadweight in time. In this regard, SGDs provide an opportunity to store all of the components of PECS in an electronic device (Lorah et al., 2015).

2.7.1.5.2. Low-tech AAC Interventions

As mentioned previously, PECS is a type of low-tech aided AAC intervention. It includes several picture cards and a board for communication. After its introduction by Bondy and Frost (1994), it became very popular and reported so many times as a good communication intervention by different researchers. For example, Hart and Banda (2009) reviewed the PECS literature from the period of 1994 to 2007. They analyzed the thirteen studies involving 39 participants. Research results indicated that PECS was highly (54% of participants) and moderately (29% of participants) effective in terms of increasing functional communication skills. Further, they investigated reported 7 participants in terms of increase in speech and found that PECS was highly effective for 2 of 7 participants, moderately effective for 2 participants, and minimally effective for 2 participants. They also found that 7 of 13 studies reported generalization of communication skills to new settings and with new trainers. Finally, PECS implementation also decreased problem behaviors for some participants as well.

In order to verify the effectiveness of PECS training for enhancing communication skills, Tien (2008) analyzed the PECS literature. The author reviewed 13 studies in the literature involving 125 participants with ASD. The study reported PECS as an alternative method that contribute to increase communication and spontaneous language of children with ASD. Besides, it makes easier to initiate the communication act. The study also includes the results of comparison of PECS and sign language training. Accordingly, PECS was preferable and was rapidly acquired method than sign language. Briefly, the study provides evidence that PECS is an effective intervention to increase functional communication skills. As a result, the literature supports the idea that PECS is an effective intervention to teach initial communication skills and accordingly increase speech development when used properly (Mirenda, 2001).

2.7.1.6. Receptive Language

In addition to use of AAC methods in expressive language, they can be used to identify receptive language as well. Ganz, Hong, Goodwyn, Kite, and Gilliland (2015) investigated the effect of tablet computer-based AAC (an iPad PECS application) on receptive discriminating of photos. They applied multiple baseline single-case design along with three selected words. Even though, they did not find significant treatment effect across all words, results indicated that there is an improvement on receptive identification of photos for two words after the implementation of PECS app instruction. This result might be related to the characteristics and individual differences of participant, so that they recommend further research focusing on receptive language aspect of AAC.

2.7.1.7. Social Communication

The term social communication determines the social interactions among peers including turn-taking and joint attention. Smiling and looking at the peer after an event that can draw child's attention is called as *joint attention* or *joint engagement* and taking an object (a toy) and giving it to a peer is named as *turn taking* (Yoder & Stone, 2006). In this regard, Therrien and Light (2018) investigated the effect of an intervention package including high-tech AAC on the social interaction of individuals with communication impairments and ASD. They took joint attention and turn taking as dependent variable. 10 preschool children (5: children with communication impairments, 5: typically developing children) participated to the study. Almost all children showed meaningful joint attention and turn taking behavior. Therefore, they concluded that use of a multicomponent AAC intervention promote the social interactions between children with no diagnosis and with communication impairments. Additionally, Yoder and Stone (2006) investigated the effect of both Responsive Education and Paralinguistic Milieu Teaching (RPMT) and PECS on three functions of intentional communication: joint attention, requesting and turn taking. For this purpose, a randomized pretest-posttest experimental study was conducted consisting of 36 children with ASD from different families. Research results indicated that RPMT is better than PECS in terms of facilitating generalized joint attention and turn taking skills. On the other hand, PECS was better in facilitating generalized requesting with little prior joint attention treatment than RPMT did.

Ganz et al., (2017) systematically reviewed the literature published between 1990 and 2015 to determine the effect of AAC interventions on social-communication for individuals with communication impairments. They reached 24 single-case experimental studies based on the inclusion criteria. They conducted their analysis relying on five potential moderators which are (1) implementer, (2) age of participants, (3) setting, (4) behavioral strategies employed during the intervention such as time delay, verbal prompt, errorless learning, and (5) communication functions like requesting. Their analysis results indicated that high-tech AAC was effective in social communication across different conditions. Firstly, in terms of first moderator, implementer, researchers found that no matter who implement the AAC, natural communication partners or researchers, they were effective in social communication. Therefore, the implantation of high-tech AACs may be thought to the parents and professional so that they take part in the implementation of AAC (Ganz et al., 2017). Secondly, research indicated that high-tech AACs are effective for all age groups, in other words they did not find a significance difference among selected age groups. Thirdly, researchers did not observe a significant difference between natural and didactic settings for social communication outcomes. Thus, high-tech AACs may be useful in any contexts (Ganz et al., 2017). Fourthly, researchers found significant effect of time delay, but did not find significant effect of verbal prompt and errorless learning on social communication outputs. Finally, although most of the studies focused on requesting, in other words expressing needs and wants, researchers found high-tech AACs effective across different communication functions.

2.7.1.8. Speech Production

It is obvious that AAC technologies facilitate the speech production, but increase on natural speech production might not occur in a short time when the AAC intervention is introduced (Millar et al., 2006). Therefore, parents and professional should be patient on this process and continue to the AAC interventions regularly. In this regard, after more than a year treatment with PECS, 59% of 66 children with ASD started to use speech as a sole communication system (Bondy & Frost, 1994). Additionally, Millar et al., (2006) systematically reviewed the 23 articles published between 1975 and 2003 about the natural speech production of individuals with speech impairments who used AAC technologies. They narrowed their investigation with the criteria that speech production data need to be collected before, during, and after the AAC interventions. The most remarkable result of research was that AAC interventions did not decrease speech production. Instead, they observed %11 no change and %89 increase on speech production.

Gevarter et al., (2015) investigated the use of SGD in terms of emitting vocalization independently. To do so, they selected four children with ASD who have similar standard communication scores. They used multiple baseline design across participants. The study reported increase in independent vocalization when vocal language interventions (e.g., reinforcing vocalizations and prompt delay) were accompanied to SGD usage. As a result, it can be concluded that instead of using SGD devices alone to teach vocalization, instructional methods also need to be provided (Mirenda, 2003).

Wojciechowski and Al-Musawi, (2017) developed a system as an assistive technology which helps children with ASD to learn pronunciation of objects in a safer way. Parents took part an active role in the progress so that children can be able to learn meaning of new words. The main philosophy behind the developed system is the fact that teaching something new to children with ASD requires so much time and patience. The system includes the use of smart phones and beacons, which are small computers that have ability to send information via wireless by using their sensors. Teaching process starts with the identification of new objects by parents. They record the pronunciation and save the images of each object by using mobile devices and stick the beacons to selected objects. Children with ASD use the smart phones or watches at home. When, the child with mobile device detects the object in a close distance, objects' images seen on the screen of mobile device and it vocalize the pronunciation of the objects. Researchers reported that use of mobile application with beacons in communication has positive outcomes. Among the two children who participated to the study learned new words and enjoyed to use of the mobile application.

2.7.1.9. Needs and Preferences of Families with Regard to AAC Use

Communication treatments require a team-work. In order to get successful results from the treatments, parents, professionals, and SLPs should take part in the process. It is also essential to take into account parents' opinions. In this regard, Meder and Wegner, (2015) surveyed parents' needs and wants towards to touchscreen-based mobile AAC technologies. They investigated families' preferences related to the both mobile devices and applications, and required support. 64 parents or caregivers of individuals who use an AAC application on a mobile device participated to the study. In terms of device and application preferences, participants were asked what mostly influenced their decision to prefer a certain (a) mobile device and (b) application in purchase for AAC, and (c) characteristics of such applications. Additionally, participants were also asked (d) who would be more beneficial for AAC support, (e) types of support parents deserved, and (f) mostly preferred professional support. In this regard, most of the participants stated that professionals' opinions about the mobile devices and applications were the most useful information in device and application purchase. In addition, they described mostly helpful AAC applications as easy to use (%37), affordable (%22), and appealing to child (%12). Furthermore, %39 of parents needed speech language pathologists' professional supports for the use of AAC at schools, however %29 of them did not request any support from a professional. The types of support that parents deserved were that teaching use of AAC device for communication (%59), customizing the AAC device (%12.8), technical support to use AAC application (%10.3), costuming the AAC application (%7.7), technical support to use AAC device (%5.1), navigating the AAC device (%2.6), and navigating the AAC application (%2.6). To sum up, parents who do not take professional support in AAC prefer easy to use mobile AAC devices and applications (Meder & Wegner, 2015).

2.7.1.10. AAC Interventions for Adults with ASD

In order to test the effectiveness of AAC interventions for adults with ASD and ID, Nepo et al., (2017) designed a multiple probe design across participants. Their primary goal was to determine how participants (a) make spontaneous requesting ("mand"), (b) discriminate symbols, (c) generalize recently acquired skills to new settings, and (d) produce vocal speech. They studied with three adults with ASD or ID who were between 31 and 44 years old. All of the participants did not have functional communication skills and not take any AAC intervention before. They used MyTalk Mobile application running on an iPod Touch device with most-to least prompting technique during the intervention sessions. At the end of the intervention sessions, all of the participants made independent requesting for a desired object and discriminated six communication symbols. They also performed high accuracy in generalization sessions, and accordingly used eight to ten communication symbols for their preferences. However, only one participant showed remarkable performance in vocal speech at the end of the both intervention and generalization sessions. Consequently, although it is not empirically supported that adults with ASD or ID produce vocal speech after an AAC intervention, they learned functional communication skills through a high-tech aided AAC with most-to-least prompting technique (Nepo et al., 2017).

2.7.1.11. Misconceptions about the Use of AAC

According to Romski and Sevcik (2005) there are several misconceptions about the incorporation of AAC technologies into language and communication development of children with disabilities. The first one is that people generally regard AAC technologies as the last option for language interventions. The problem is that they struggle for the solution by trying different strategies, but once the interventions are failed one by one, then they turn AAC. The other misconception is that AAC influence children's language development negatively. People think that once the child use AAC, it will be the sole communication mode for child and s/he won’t speak anymore. Additionally, some believe that in order to profit from AAC systems, children need to have certain skills. Furthermore, many families consider that the introduction of an AAC to at early ages can hinder natural speech-development of children. However, there is no enough empirical evidence that support these myths in the literature (Romski & Sevcik, 2005). On the contrary, it has been shown that AAC interventions enhance the speech development (Binger, Berens, Kent-Walsh, & Taylor, 2008). One more misconception is about the chronological age of the children to start interventions. Despite the importance of early intervention, AAC systems are not introduced to the children with communication impairments before the 2 years old (Light, 1997). However, it is certain that early intervention is so crucial to improve their expressive and receptive communication (Light, 1997).

2.7.1.12. Communication Proficiency for Individuals with ASD

The communication proficiency is a set of abilities that facilitates communication acts. In order to support communication proficiency of individuals with communication impairments, adequate knowledge, skills and judgement should be integrated into linguistic, operational, social and strategic domains of communication (Light, 1989). These four communication proficiencies were introduced by Light in 1989 and detailed as follows. First, the linguistic proficiency addresses to the degree of knowledge and skills in both expressive and receptive language codes employed by individuals using AAC. Second, in order to use AAC systems effectively sufficient technical knowledge and skills is required to operate the system. Third, communication acts are occurred in a socio-relational and socio-linguistic context, therefore individuals using AAC need to obtain, knowledge, skills and judgement about social rules. Forth, it is also essential to have adequate knowledge, skills, and judgement to make strategic decisions in linguistic, operational, and social domains of communication. According to Light and McNaughton (2014) despite the past few years, four domains of communication still maintain their validity for individuals using AAC. However, the communication demands for individuals using AAC changed over the past years. While face to face communication between individual with communication impairments and communication partner was the sole demand in previous years, the importance of both written communication and social interaction through social media increased. Therefore, the scope of each proficiency expanded since the demand for language and literacy skills is increased, rapid developments on both mobile devices and social media usage changed the operational demand, and new social skills emerged within the social arena (Light & McNaughton, 2014).

There are internal and external factors that support communication proficiency of individuals using AAC. Motivation to communicate, attitude toward AAC, communication confidence, and resilience are psychological based internal factors that foster communication proficiency (Light & McNaughton, 2014). On the other hand, policy, practice, attitude, knowledge and skills are the environmental factors that facilitate communication proficiency. In this regard, according to Light and McNaughton (2014), policy makers should focus on legislations to make easier to the use of AAC systems. Additionally, professional training support should be provided for individual using AAC systems (Andzik et al., 2018). In order to make AAC interventions available for individuals with complex communication needs, several informative workshops for parents and stakeholders need to be held to influence their attitudes toward the AAC, to give knowledge about AAC systems, and to increase their awareness regarding interaction strategies.

2.8. Design Specifications of AAC Technologies

Due to the external factors related to the design of AAC technologies, most of the time high-tech aided AAC technologies do not provide adequate communication and language development for children with communication impairments (Light & Drager, 2007). These factors might be related to the appeal and capabilities of the

AAC technologies, and the rapport that is created by the child and the society in which the communication acts are occurred and influence children attitudes, perceptions and motivations toward the AAC systems.

The fact is that design specifications of AAC systems might vary according to children's needs and skills. For example, design specifications addressing children with ASD might be different than those of children with physical disability. Indeed, Light and Drager, (2002), proposed several guidelines to make AAC systems more appealing, engaging and ideal for children with communication impairments. Accordingly, these systems should be as appealing as possible to capture and sustain children's interest. They should be integrated children's daily life easily. In doing so, child's cultural and linguistic background should be taking into account. The system should provide opportunity for children to improve their expressive and receptive language. The system should be usable so that children can use it without making much effort. Since the children's needs might vary over the long term, the system should keep up with this improvement and be open to make process in time. Finally, families and trainers could be able to learn and use the system.

According to Light et al., (2004), there are three benefits of designing AAC systems more appealing for children with communication impairments. First, children tend to use AAC systems for their communication needs willingly. Second, typically developing children's attitudes toward the children using AAC systems can change positively. By means of that children can initiate communication with their peers more easily. Last, children's perception towards themselves might change positively if they find AAC systems more attractive.

2.8.1. Future Dimension of High-tech AAC Design

In order to reveal the design concerns of AAC systems, Light et al., (2007) conducted a study with children between 7 and 10, and had not prior experience with AAC. The study was formed based on the participatory design method by taking typically developing children as stakeholders in the language acquisition process of children with communication impairments. The study proposed several suggestions to make AAC systems more attractive and engaging for children. The first fundamental feature that made young children's AAC design different than traditional ACC systems was their functionality. According to research results young children attributed a role to AAC systems that not only included the communication needs of children but also promoted their social interactions. Furthermore, such systems should be supported multiple functions such as telephone, email, play and so on. The second essential aspect was related to the appearance of the AAC systems. In this sense, research results indicated that future AAC systems should be customizable and be personalized. Because humor is important for children, it should be embedded to the AAC systems through sounds effects and appearance. Colors employed at the system should be bright and lights presented in an appropriate way. And the system should support popular themes that varies individual differences. To sum up, the study merely focused on the young children's preferences and priorities in designing ACC systems, but did not provide empirical evidence for the proposed design specifications.

Light et al., (2004) compared design features of AAC systems and popular toys. The research results provided several insights to the design concerns of future AAC systems. The first concern was about the use of colors. The research suggested that multiple color option should be incorporated into design. It should also support bright glossy colors. Second, the material employed on the AAC systems should be attractive for children. Third, AAC systems should be provided a variety of shapes. Instead of merely providing them as traditional box shape, different shapes should be incorporated like animals. Forth, the systems should be as portable as possible so that children can carry out it. Fifth, AAC systems should support multiple options for movement and actions. In other words, the system should incorporate varied ways to utilize its certain features. While doing that, the system should provide immediate feedback for the user's actions. Sixth, there should be a variety of sound options for use. Seventh, appropriate lights should be incorporated to the system to catch children's attention. They should also lead users to certain actions by providing suitable feedbacks. Finally, the theme of the systems should be personalized according to children's needs. Consequently, the AAC systems should be highly appealing for children with communication impairments so that they are determined to use them, sustain their interest and enhance their self-esteem (Light et al., 2004).

2.8.2. Just-in-Time Programming

Each individual who use AAC technologies demands specific vocabularies for their language development, so that the vocabularies that are selected for AAC system should be personalized according users' needs (Beukelman, McGinnis, & Morrow, 1991). Just in time (JIT) allow users to specialize the concepts on the high-tech AAC device. It specifically addresses the instant programming of a concept on AAC technologies when individuals need to express it (Schlosser et al., 2016). It is a flexible way of programming concepts on the AAC device. By means of this feature, meaningful events and remarkable objects are captured and named with an appropriate vocabulary on the device (Holyfield, Caron, Drager, & Light, 2018).

Programming steps of a high-tech AAC device should be clear and useable. For example, Caron, Light, Davidoff, and Drager, (2017) investigated the comparison effect of three commonly used AAC applications (GoTalk Now, AutisMate, EasyVSD) on programming time. 10 persons from different professionals participated to the study to complete three off-line tasks by using selected AAC applications, which were prepared previously by researchers. The research results showed that participants get least programming time score form EasyVSD application. As a result, researchers concluded that in order to decrease the programming time of AAC applications, the operational competence that is required to operate the AAC application should be as simple as possible. Additionally, Caron, Light, & Drager, (2016) compared two AAC application in terms of creating vocabulary concept, activating visual scene display and children's engagement with the applications. While one of this application required more programming steps, the other one required fewer programming steps.

They reached the conclusion that professionals interacting with AAC application that required fewer programming steps added more vocabulary concepts and visual scenes for children with communication impairments. That is, complicated applications allow parents or trainers to allocate fewer resources to the interaction (Caron et al., 2016). They also revealed that student engagement with the AAC application requiring fewer programming steps was higher than the other one.

Holyfield, Drager, Light, & Caron (2017) examined participations of young children's to "Just-in-Time" programming of vocabulary concepts on an AAC mobile application supporting visual scene display. They studied with 10 toddlers who were between 10 and 24 months and were typically developing in language and motor skills. The study indicated that all of the children participated JIT programming process successfully. This result gave insight into design of AAC technologies in that simplified AAC technologies with adequate support including time delay, prompting and modeling can facilitate the participation of young children to programming process of vocabulary concepts, even they are in 10 months.

2.8.3. Layout and Organization

The concepts that are acquired by children are represented as visuals on the screen of AAC technologies. The layout and the organization of these concepts also a design concern on which a great effort need to be made. The layout and organization of these representations should facilitate the user to reach these concepts effectively (Light & Drager, 2007). According to Light and Drager (2007), grouping and arrangement are the two frequently used methods to illustrate the representations on the screen. The organization procedure is made based on the concepts which are contextually related to each other, which is called as dynamic systems displays. Drager, Light, Speltz, Fallon, and Jeffries, (2003) examined the learning demands of three dynamic systems displays, which are taxonomic grid, schematic grid, schematic scene. Researchers randomly assigned 10 typically developing children for each system displays so that they locate 12 vocabulary items on them. Accordingly, the research indicated that although there is no significant difference among the selected approaches, children located more vocabulary items on schematic scene than taxonomic and schematic grid. The research provided insight that in order to reduce learning demands and to make AAC technologies more appropriate for children, they should be redesigned.

2.8.4. Navigation

Navigation is a facilitate that help users to move across different pages of the AAC systems to reach to the required concepts. While designing the navigation systems, a special attention need to be paid to make it more usable for children. Because, children need to know how to access to the hidden pages and associations between hidden pages and representations, navigation system might be difficult to handle for young children (Light & Drager, 2007). According to Light and Drager (2007) navigation systems should be supported with appropriate visuals or cues to make it much easier to figure out the relations between hidden pages and representations. Drager et al., (2004) designed three dynamic menu options to understand typically developing 3-year-olds' performance on locating vocabulary items across these three conditions. The first navigation included a grid layout on which simple symbols were located to access the target page. The second navigation included a grid layout on which screen shots of the represented page were located. The third navigation, on the other hand, included contextual scene–screen shot display. Although, they did not find a significant difference for improving performance among these conditions at the first implementation, they observed that performance scores of contextual scene–screen shot display was better than other two grid displays. The study indicated that contextual scene–screen shot display may be a good navigation system for AAC technologies.

2.8.5. Selection Technique

AAC systems demand a selection technique to help children with communication impairments to express their needs. It is important because it serves as a bridge between the child and the system. The child interacts with the AAC system via selection techniques. Standard keyboards and mousses may be used for this purpose. However, these devices require not only higher fine motor control to use them, but also an estimate to understand the results of each action that is performed with such devices (Light & Drager, 2007). The key point, here, is that the selection technique should be compatible with the child's motor and cognitive demands. An alternative for the selection techniques is the use of touchscreens that are supported by a variety of devices. This technique has an ability that help child to estimate each actions' results by merely touching it (Light & Drager, 2007). One more technique that might be used for this purpose is "scanning", which is reported by Light and Drager (2007). It is an interface that scan the children's' face, hands, eyes and so on to make a decision about their intentional selections. This technique demands device dependent control to which artificial intelligence is embedded based on clinical studies in psychology and human computer interaction.

2.8.6. Output Systems

The communication procedure is occurred in an order that first the child interacts with the AAC system, and then s/he selects the target concept. In this regard, the system needs to provide a reaction so that the communication partner understands the child's needs. The output that is generated by the AAC systems might be in different forms such as screen display and speech output (Light & Drager, 2007). While deciding the output of the AAC system, it is crucial to associate output of the system with the possible response to such output by the communication partner. A majority of the people in the society must understand these outputs easily. Most of the AAC systems, nowadays, support both screen display and speech output that might be digitalized and synthetic. In this regard, future research is required to examine intelligibility of words and sentences that are generated by AAC system via screen display, synthetically produced speech or digitized natural speech, or combination of these.

2.8.6.1. Digitized Speech Production

Digitized speech requires a previously recorded human voice (Schlosser & Koul, 2015). In order to store a human voice (analog sounds) to a certain device, they firstly need to be transformed to analog voltages which are then converted into binary codes. During this process, all of the analog signals do not transformed to digital forms. Rather, sampling technique is used to compose digital data from sound waves in certain intervals. In this regard, SGDs produced a speech by converting the digital sound data to analog output. Although there is no enough empirical evidence for intelligibility of digitized speech of SGDs, it is certain that it is a form of or close to natural speech (Drager, Clark-Serpentine, Johnson, & Roeser, 2006). There are also several factors that affect the quality and intangibility of digitalized speech produced by SGDs. These factors are related to the environment where the recording is performed, the quality of speech being recorded, the quality of technical infrastructure for recording, and sampling rate gathered from sound waves. In order to gather better results in speech production, these factors need to be optimized for better recording quality. To sum up, because the digitized speech is more intelligible than synthesized speech (Drager et al., 2006) for communication partners, it might be a good option for individuals with limited speech (Schlosser & Koul, 2015). However, this option requires additional storage on a SGD. Besides, communication messages need to be predetermined (Drager et al., 2006) and recorded before starting the communication act.

2.8.6.2. Synthetic Speech Production

Synthesized Speech is procured by a certain device by converting a specific text to speech output (Schlosser & Koul, 2015) through a synthetic algorithm. Contrary to digitized speech, it does not require a voice recording and thereby provides unlimited speech capability. However, it is less intelligible in a single word production than natural speech (Mirenda & Beukelman, 1987). In order to make synthesized speech more intelligible, contextual information (Drager et al., 2006; Mirenda & Beukelman, 1987) related to the message need to be provided. Additionally, listening conditions

(Drager et al., 2006) of communication partners need to be optimized. Even though it is clear from the literature that individuals with communication impairments have difficulties in perceiving and compressing the synthesized speech, it is also promising for such individuals in recognizing synthesized speech after a period of exposing treatment (Koul & Hester, 2006).

2.8.6.3. Comparison of Digitized and Synthetic Speech

There is no clear evidence in the literature about the effectiveness of digitized and synthetic speech for individuals with communication impairments. However, digitized and synthesized speech outputs were compared in terms of intangibility for typically developing children in different points of views. In these studies, intangibilities of messages were measured with the number of messages repeated by listener correctly. Drager et al., (2006), for example, investigated this issue in an experimental condition with 90 typically developing children who were between three and five years old. Accordingly, age had significant effect on intangibility of message outputs. Four and five years old children repeated correct messages significantly than three year olds. They also provided clear evidence that contextual information that might be any form of cue influenced the intangibility. Additionally, intangibility of short messages (single words) were lower than those of long messages (sentence). In general, the intangibility of digitized speech was statistically higher than synthesized speech for long messages out of context. However, possible communication partners might have difficulties in understanding the single words produced from an AAC device since there is no clear evidence of higher intangibility of short messages than long messages (Drager et al., 2006).

The preferences and effectiveness of speech types offered with assistive technologies were also investigated by Hux, Knollman-Porter, Brown, and Wallace (2017). 20 adults with aphasia evaluated the understandability, naturality, and clarity of 60 sentences after they had listened them on a computer. The study indicated that digitized speech was significantly better intangible than synthesized speech and more preferable than synthesized speech for individuals with aphasia. Although individuals with aphasia can comprehend the synthesized speech to some extent, the current synthetic speech technology is far away from the understandability of natural speech (Hux et al., 2017).

2.9. Summary and Implications of the Literature

Autism Spectrum Disorder (ASD) is a neurodevelopmental disorder that has two essential symptoms including deficit in social reciprocity and presence of atypical behaviors (American Psychiatric Association, 2013). As a result of that different treatment methods including educational and behavioral approaches, and communication trainings are used the overcome problems they generally faced. In present study, to enhance the functional communication skills of individuals with ASD, a communication treatment was conducted with a high-tech alternative and augmentative communication (AAC) application.

There was empirical evidence that AAC interventions are effective in expressive language (Alzrayer, Banda, & Koul, 2017; An et al., 2017; Genc-Tosun & Kurt, 2017; Schepis, Reid, Behrmann, & Sutton, 1998), receptive language (Ganz, Hong, Goodwyn, Kite, & Gilliland, 2015) , social communication (Therrien & Light, 2018; Yoder & Stone, 2006), speech production (Gevarter et al., 2015; Wojciechowski & Al-Musawi, 2017). Most of the communication treatments take its roots from the theoretical orientations in verbal behavior proposed by Skinner (1957). Skinner suggests starting communication treatment with “mand”, which is an act to request a preferred object. Therefore, AAC interventions generally focus on treatments to teach requesting skills to individuals with ASD.

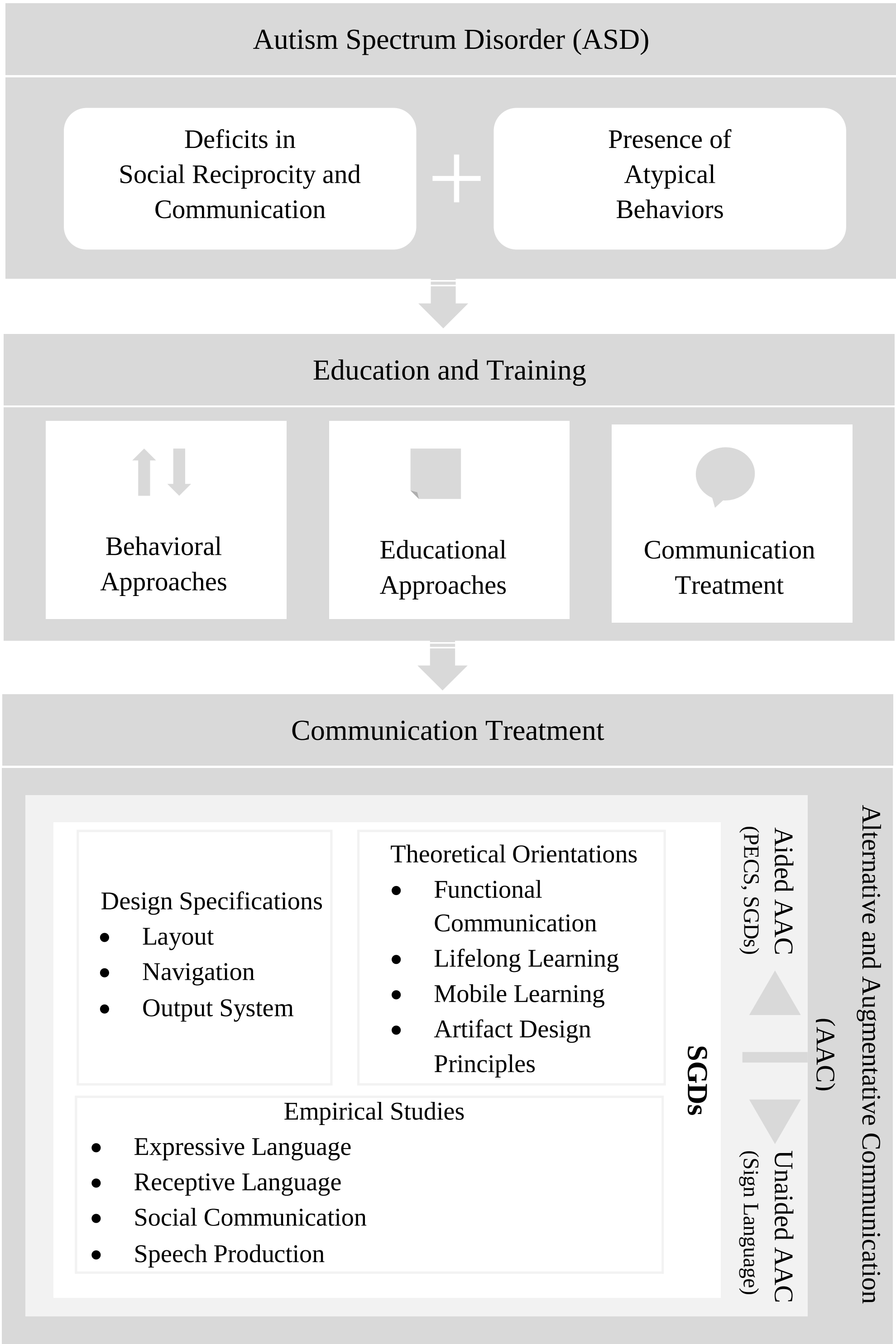


Figure 2.1. Organization of the Literature

It is well-known that the design of an instructional material affects the learning. Because a complicated and unusable design increase cognitive load of the learner, it may influence learning performance of the learner negatively (Mayer, 2001). Therefore, it is suggested to decrease extraneous cognitive load of the learner by ensuring usable instructional materials. In this case, the usability of the material refers to the effectiveness, efficiency, satisfaction (ISO 9241-11, 1988) learnability and memorability of the design (Nielsen, 1993). One way of doing that is to take learners characteristics into account, in other words to provide user centered designs (Norman, 1986). In this regard a variety of usability heuristics (Nielsen, 1993) have been proposed to enhance user interfaces for typically developing individuals. However, due to the lack of information how individuals with disabilities process information, design guidelines might be difficult to implement in special education. In this regard, there is lack of literature how to design AAC application. Therefore, individuals related to the problem situation in special education should be analyzed in a detail way, and based on their characteristics flexible applications should be provided.

The Table 2.2. presents the design specifications possible AAC systems derived from the literature detailed above. As it can be inferred from the Table, three core design specification were suggested in the literature, which are appealing, flexibility, functionality, and usability. In present study, therefore, these specifications were taken into account and presented a high-tech AAC application named EBA.

Table 2.2. *The Summary of Design Specification of AAC Systems*

Theme	Design Specification	Reference
Appealing Design	The system should be appealing to capture and sustain children’s attention.	(Light et al., 2004; Light & Drager, 2002)
	Colors should be bright and light to take children's attention.	(Light et al., 2004; Light et al., 2007)

	The system should support dynamic system display on which contextually related concepts are grouped.	Light et al., (2007)
	The navigation system should support appropriate visuals and cues.	Light et al., (2007)
Appealing and Flexible Design	Multiple color option should be incorporated into the system.	Light et al., (2004)
	Popular user themes should be supported and need to be personalized.	(Light et al., 2004; Light et al., 2007)
Flexible Design	The design should be personalized to meet the individual differences including cultural and linguistic background.	(Light & Drager, 2002; Light et al., 2007)
	The should be open to the new improvements.	(Light & Drager, 2002)
	The AAC system should be functional by which user make social interactions.	Light et al., (2007)
	The system should provide multiple facilities including telephone, email, social media, play etc.	Light et al., (2007)
	The system should provide immediate feedback to the user actions.	Light et al., (2004)
	Sound should be generated in different ways: digitized and synthetic.	(Drager et al., 2006; Light et al., 2004)
	Just-in-Time Programming should be supported.	(Beukelman et al., 1991; Caron et al., 2017; Holyfield et al., 2018,

		2017a; Schlosser et al., 2016)
	Multiple selection techniques should be supported depending on the characteristics of children.	(Light & Drager, 2007)
	Contextual information should be provided with digitized speech output.	(Drager et al., 2006; Mirenda & Beukelman, 1987)
	The system should support digitized speech since its intangibility is higher than synthetic speech.	(Drager et al., 2006; Hux et al., 2017)
Usable Design	The design should be usable children and practitioners.	(Light & Drager, 2002)
	Operational demands of the system should be simple.	(Caron et al., 2017, 2016; Holyfield et al., 2017a)

The Figure 2.1 illustrates the organization of the literature part of the present study. In conclusion, there is lack of literature regarding the use of high-tech AAC system in functional communication needs of individuals with ASD in Turkey (Genç-Tosun & Kurt, 2017). There is also lack of literature how to design such applications. From this point of view, we developed the EBA based on the design specifications presented at Table 2.2. It is expected that the present study would be a pioneer in the field for the forthcoming studies.

CHAPTER 3

METHODOLOGY

Design based research (DBR) was employed in the current study. Design based research is a research framework that is “the systematic study of designing, developing and evaluating instructional programs, processes and products that must meet the criteria of internal consistency and effectiveness” (Seels & Richey, 1994). It is also labeled as “developmental research” (Richey, Klein, & Nelson, 2004; van den Akker, 1999), “formative research” (Newman, 1990; Reigeluth & Frick, 1999), and “design experiments” (Collins, 1992) in literature. In this study, the term of “design based research” (DBR) was preferred to address the methodology.

In this chapter the purpose of study, design of study, participants, data collection process, data analysis process, and reliability and validity concerns were presented according to Type 1 design based research procedures.

3.1. Purpose of the Study

Mobile technologies have become an indispensable part of the learning environments due to their capabilities for supporting learning activities. In recent years, they also integrated into special education since they facilitate routine operations of people with disabilities. In this regard, a variety of applications have released in the market, which are customized for the requirements of individuals with communication impairments including ASD. However, almost all of the studies have been focused on the desirable outcomes of such technologies after their implementation. But few studies have reported the development process of such application with their validation. In this regard, the main purpose of the current study is to investigate the qualities of mobile applications that is designed to enhance functional communication of individuals with

ASD. Additionally, it is also aimed to assess the validation of developed application in enhancing functional communication and requesting skills.

3.2. Research Questions

Design based research (DBR) connects real life problems and educational research (Amiel & Reeves, 2008) and focuses on a wide-scoped and complicated problem that is important to education (Reeves, Herrington, & Oliver, 2004). The ultimate goal of the DBR is not test a theory whether it is a good predictor of a certain variable or not (van den Akker, 1999), so that DBR start with the analysis of the real-life problems (Amiel & Reeves, 2008; Reeves, 2000; Reeves et al., 2004). As a result of that, hypotheses are not stated at the beginning of the study since it is not an empirical study, but research questions are provided. (Richey & Klein, 2005; Richey et al., 2004). In this regard, in order to understand improvement and implementation process of mobile application designed for individuals with ASD and to enhance their communication skills, the following research questions were investigated:

- What are the teachers' opinion towards the use of mobile technologies in special education?
- What are the design principles of mobile applications designed for communication needs of individuals with ASD based on the subject-matter experts' considerations?
- How effective is the mobile application in functional communication for individuals with ASD?
    - How effective is the mobile application in requesting a desired object for individuals with ASD?

3.3. Design of the Study

There are two types of DBR (Richey & Klein, 2005; Richey et al., 2004) depending on the nature of the solution that is provided for the problem situation. Type 1 studies focus on instructional products, process or tools, on the other hand, Type 2 studies focus on a proposed design, development or evaluation of a model (Richey & Klein, 2005).

As indicated previously, the ultimate goal of the current study was to develop a valid, effective and user-friendly mobile application that could be used for the communication needs of individuals with ASD or communication impairments. To do so, subject matters' considerations were taken into account. After the ultimate version of application was developed, the application was implemented in class and real life settings to understand its validation. In this regard, the Type 1 DBR requirements were employed throughout the current study since the focus of the study was the design, development and evaluation of an instructional mobile application being planned to use in communication needs of people with communication impairments. The Type 1 DBR was conducted based on the framework proposed by Reeves (2000) and Reeves et al., (2004). Additionally, the prototyping procedure was accelerated according to Tripp and Bichelmeyer (1990)'s suggestions.

3.4. Summary of the Design

The detail of the research design is presented at the following part. In order not make the readers confused, the summary of the methodology is provided in advance.

3.4.1. Research Methods

Current study takes the Type 1 design based research framework proposed Richey et al., (2004) as the research methodology to investigate the research questions presented before. The DBR does not propose a new paradigm in research methodologies, but is the combination of different research methods to seek real-life problems in natural contexts. Therefore, multiple research methods are used in DBR framework (Wang & Hannafin, 2005) and they don't have to be different than other research methods (van den Akker, 1999). In this study, several research methods were used depending on the nature of research questions. These methods were detailed below; in this section, they were briefly summarized at Table 3.1.

Table 3.1. *Summary of Research Methods used in Current Study*

Methods	Analysis	Design & Development			Evaluation
		First Prototype	Second Prototype	Third Prototype	
Literature Review	+	-	-	-	-
Focus Group Study	+	-	-	-	-
Expert Review (in depth interview)	-	-	+	-	-
Expert Review (survey)	-	-	-	+	-
Implementation of EBA (Case Study)	-	-	-	-	+

The main purpose of this study was to investigate the use of mobile application for the communication needs of individuals with ASD. In this regard, in the analysis phase characteristics of such individuals and possible mobile application (EBA) were examined by conducting a literature review and a focus group. Based on the results of both literature review and focus group study, prototypes of the EBA were released. An in-depth interview was conducted to evaluate one of these prototypes by an expert in the field. Based on the considerations of expert, several refinements were made on the EBA. The last version of EBA was evaluated by a group of academicians in the field trough an online survey. In doing so, an introductory video of the EBA was created and uploaded to a video-sharing website. Participants first watched the video and evaluated the mobile application. The ultimate version of the EBA was developed at the end of the prototyping procedure. All the methods used in analysis, design and evaluation phase were employed to seek the first research question that concerns the design issues of EBA.

In evaluation phase, the EBA was tested in the field. In this phase, actual use of EBA in daily life was investigated. This phase involves the investigation of both second research questions. That is, how children with ASD make request by using EBA.

3.4.2. Participants

Design based research aims to find a practical solution for the real-life problems. In doing so, practitioners from different disciplines and people directly related to the problem can participate to the study. Additionally, the researcher also takes place as a co-participant and involves all of the phases of the study. Briefly, the number and the characteristics of the participants in DBR might vary depending on the requirements of each phase (Richey & Klein, 2005; Richey et al., 2004).

During the analysis, design, development and implementation procedure of the mobile application, different participants from a variety of professionals and children with ASD participated to the study. While selecting the participants purposive sampling method was employed since the study required participants with special qualities. The characteristics of each participant were detailed at the following section. The number of participants was summarized on the Table 3.2.

In analysis phase, possible design issues of mobile application (EBA) specialized for the communication needs of individuals with ASD was examined. In this phase, a male and four female special education teachers participated to the study. They had three to five years-experiences in the field and had at least a child with ASD in their class during this period.

In design and development phase, the EBA was improved based on the considerations of special education teachers and academicians. Firstly, the EBA was evaluated by a special education teacher after he had experienced with the application for a while. He had ten years-experience in special education and had been managing a course about material design for handicapped students in a state university. Secondly, a formative evaluation was conducted on the ultimate prototype of EBA with eight academicians in special education field. They had three to twenty years-experience in academia. While two of them had PhD degree, the others had master degree and were PhD candidates.

Table 3.2. *The Number of Participants Throughout the Study*

Methods	Analysis	Design & Development			Evaluation
		First Prototype	Second Prototype	Third Prototype	
Special Education Teachers	5	-	1	-	-
Subject Matter Expert (Academician)	-	-	-	8	-
Target Group (Children with ASD)	-	-	2	-	3

In evaluation phase, the final product was implemented in accordance with previously determined sub-sequential tasks' procedures (see Table 3.10). In this phase, the summative evaluation of the EBA was evaluated. The test the EBA, three children with selected from Erzincan province according to purposive sampling technique. Their ages were changed from 4.5 to 6.5 years. While selecting the children, a prerequisite skills-form was filled by the parents. Based on the criteria on this form, they were purposively selected. The detail of selection procedure and characteristics of all participants were presented at the following section.

In addition to the participants, several practitioners also contributed to conduct the study in a suitable way. In this regard, two instructional technologists, an expert in special education and educational science participated to the inter-observer agreement of analysis results in analysis phase. In evaluation phase of the study, we gathered information about children from their parents. They, filled the demographic information form, the prerequisite form and the reinforcement form. During the implementation of the EBA, special education teachers, sometimes parents and trainee teachers accompanied to the participants. Consequently, special education teachers, parents and academicians in instructional technology, in special education and educational sciences participated as a practitioner throughout the study.

3.4.3. Instruments

Due to the multiple research methods being used in DBR framework, a variety of instruments were employed throughout the current study. Table 3.3 illustrates these instruments in general. The detail of each instrument presented the following section.

In analysis phase, a focus group study was carried out with five special education teachers. Before conducting the focus group an interview protocol (Appendix C) was prepared by considering the first research question. Then, it was send an instructional technologist and an expert in special education to confirm its validity. Based on their considerations the final form of the instrument was prepared. The instrument included three sections: introduction, body and conclusion. In the introduction part, it was aimed to establish a rapport with the participants. In the body part, questions that might be touch on the critical issues in designing possible mobile applications for individuals with ASD to enhance their functional communication were asked. In conclusion part the whole instrument was summarized.

In prototyping procedure, formative evaluation of the designed application (EBA) was conducted. Two expert reviews were carried out with a special education teacher and eight academicians in special education. An interview protocol (Appendix D) was prepared for the first expert review study. It involved twelve interview questions about the appropriateness of EBA for the purpose of the study and for the characteristics of children with ASD, the content inside the EBA, the user interface and so on. The instrument, then, sent to two instructional technologists and based on their feedback, the instrument was finalized for the implementation. The second expert review, on the other hand, was conducted through an online survey (Appendix E). There were three sections of the survey; consent form, demographic information part and survey questions. While preparing the survey, we utilized the questions on the first expert review instrument to ensure the consistency between two reviews. The first seven questions provided in a form consisting of rating scale and open-ended questions, the rest of the questions was merely open ended.

Table 3.3. *Summary of Instruments Used Throughout the Study*

Methods	Analysis	Design & Development			Evaluation
		First Prototype	Second Prototype	Third Prototype	
Focus group interview protocol	+	-	-	-	-
Expert review interview protocol	-	-	+	-	-
Online survey with open-ended questions	-	-	-	+	-
Observation form	-	-	-	-	+

In evaluation phase, children with ASD were observed after the intervention in terms of how they requested for a desired object. During the observation sessions, an observation form (Appendix L) was used. While preparing the items on the observation form, we utilized the task analysis procedure and related literature.

3.4.4. Data Collection and Analysis

Both qualitative and quantitative data collection methods were employed throughout the study. The detail of data collection and analysis procedure was provided following section. In this part, merely the summary of overall procedure was presented.

In analysis phase a focus group interview was conducted with special education teachers. The study lasted about an hour and the whole session was recorded. During the data collection process, participants were encouraged to give more contribution regarding what they think about the topic. In order to analyze the data, qualitative data analysis procedure suggested by Corbin and Strauss (2008) was employed.

In prototyping procedure, two expert reviews were conducted to make the formative evaluation of EBA. In first expert review, an in-depth interview was conducted with an expert in special education. In doing so, first the expert experienced with the EBA for a while, then the interview was started and tape-record was taken during the study. Qualitative data analysis procedure was employed to analyze the first expert review data. In the second expert review, the introductory video of EBA was presented and uploaded to a video sharing web site. Additionally, an online survey with open ended questions was prepared so that the participants first watch the video and then fill the survey. The survey and video links were sent different academicians in special education. Some of them responded positively and filled the survey. To analyze the second expert review data, quantitative data analysis procedure was employed in general. Additionally, for the questions consisting of rating scale on the survey, several statistical calculations were made.

In evaluation phase of the study, children with ASD were observed during the, intervention and follow-up sessions. To collect data during this process, observation forms were employed. The data collected each session were presented in a line-graph to reveal the effect of intervention clearly to some extent.

3.4.5. Procedure

The main purpose of this study is to investigate the characteristics and the use of EBA application designed for the communication needs of individuals with ASD. The Type 1 DBR (Richey & Klein, 2005; Richey et al., 2004) framework was applied to examine previously presented research questions. The Type 1 was selected in the current study because this study focuses on the design, development, and implementation and validation of a new instructional material.

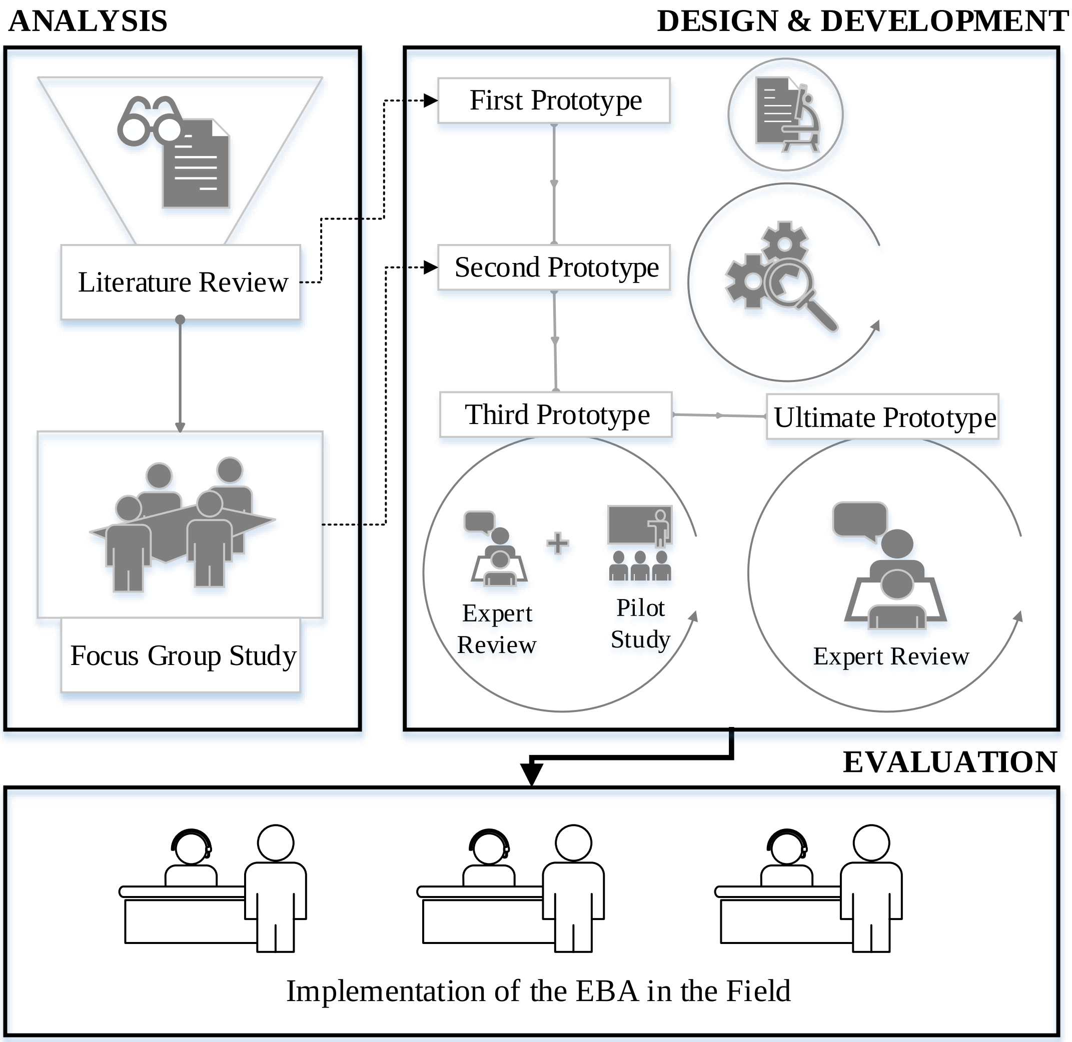


Figure 3.1. Design based research phases in current study

Design based studies deal with real life problems by nature. These problems are investigated in their contexts by utilizing the existing theories. Current study focuses on a commonly seen problem that is the communication impairments of individuals with ASD. Because they have difficulties in expressing themselves in their life, they do not fulfill their needs easily. And consequently, several disruptive or atypical behaviors are observed that influence the whole life of such individuals. From this point of view, current study combines the principles of applied behavior analysis, especially the arguments of Skinner (1957) in verbal behavior, and recent mobile technological affordances to enhance communication skills and to reduce the undesirable behaviors of individuals with ASD.

A traditional DBR includes cycles from the analysis of problem situation through the implementation of developed product. A variety of different professionals are involved in different phases of DBR. In this regard, researchers and practitioners in special education discipline worked collaboratively. Figure 3.1 illustrates the whole process of current study. The detail of the process was also presented at Appendix N.

Design and development phases follow the analysis phase and called as prototyping procedure. Due to the little experience of researcher in the special education field and the complex factors like communication issue affecting problem situation, the prototyping procedure was accelerated as suggested by Tripp and Bichelmeyer, (1990). In other words, the analysis and prototyping procedure was intersected into a nested process. As a result of that, initially the first prototype of the application was developed after the literature review. Then, first prototype was reviewed after the focus group study results and the second prototype was released. Afterwards, the second prototype of the mobile application was reviewed by an expert who has experience in practice setting, and is a lecturer in special education in a state university and gives course about material design for the children with intellectual disabilities. Shortly after the expert review, we conduct a pilot study in the field to observe the applicability of application. By taking into account the expert review results and the observation results in pilot study, several refinements were again made on the application, and accordingly the third prototype was released. The third prototype was reviewed by eight academicians whose experience was 3 to 20 to evaluate the application from an academic point of view. As a result, the final prototype was developed according to last expert review results and experiences of researcher throughout the process.

In order to investigate the validation of EBA in the field, the application was tested by researcher and the four practitioners on three individuals with ASD. The detail of analysis, design, development and evaluation phases were elaborated below.

3.4.5.1. Role of the Researcher

The researcher in DBR framework collaborate with the practitioners throughout the process (Reeves, 2000; Reeves, Herrington, & Oliver, 2004), which makes them by default participants of the study. Table 3.4 summarizes the role of the researcher during the study. As it can be inferred from the Table 3.4, the researcher took different roles including practitioner, data collector and analyzer throughout the process.

Table 3.4. *Role of the Researcher Throughout the Process*

Phase	*Research Method*	*Researcher*	*Role*
Analysis Phase	Focus Group Study	Manager of the focus group	• Analyze the communication problem of individuals with ASD
Prototyping Phase	Expert Review I	Interviewer	• Introduce the first prototype of the EBA to the expert • Analyze the design specification of the EBA
	Pilot Study	Physical Prompter	• Help to children to initiate functional communication • Analyze the video recording to understand how children with ASD make request.

	Expert Review II	Presenter	• Prepare an introductory video of the EBA and share it with the academicians in the field. • Prepare an online survey and share it with the participants • Analyze the online survey data
Evaluation Phase	Case Study	Physical Prompter, Communication Partner	• Help children with ASD to make simple and multi-step request. • Role as a communication partner to whom individuals with ASD need to approach to initiate the communication • Analyze the video recording to understand how children with ASD initiate functional communication and make request.

3.4.5.2. Material (The First Prototype of the EBA)

This section consists of two parts: first brief description of EBA with reference to literature and second essential features of the application.

3.4.5.2.1. Description of the EBA

EBA is a mobile application platform designed by the researcher to enhance functional communication skills of individuals with ASD. The name of the application (EBA) comes from a common expression in Turkish that is "**E**ngelleri **B**irlikte **A**şalım", which means let's overcome the obstacles together. It aims to improve the expressive language of such individuals by teaching requesting for a desired object (mand). From this point of view, it utilizes theoretical arguments of *Verbal Behavior* proposed by Skinner (1957), which is frequently referenced book in special education.

Approximately 30 % of individuals with ASD suffer from speech difficulties (Wodka et al., 2013) and to overcome this problem AAC methods are used (Mirenda, 2001). In this regard, EBA is an assistive technology that could be used as an aided AAC tool. It provides not only an alternative way for communication but also an augmentative speech capability (Lorah et al., 2015) as an AAC tool.

The EBA is a mobile-software that uses the capabilities of tablet computers such as image capturing, voice recording, speech generating, data storing and the like. It differs from SGDs and VOCAs because it might be personalized in the line with the requirements of users depending on the capabilities of mobile devices. Furthermore, it includes visual and auditory cues for functional communication.

EBA does not claim to enhance functional communication by itself. Instead, it requires a method by which to teach the functional communication. In this study, a similar procedure to PECS protocols (Bondy & Frost, 1994) were employed. In this regard, it provides several essential features that help to build sentence structure in functional communication.

Technically, the EBA application was designed in the form that could run on Android mobile devices. It can be installed any Android devices upper from 18 API level. The application demands at least two system requirements: camera and microphone usage. The file size of the first prototype of the application consists of nearly 6 MB. However, the application demands additional storage in time because once the new communication objects are added to the system, they are stored in the external or internal storage of the device. Apart from essential requirements, which are the camera, microphone, and storage, it does not demand any specific hardware on the devices.

The EBA includes several essential features including user account, categories, learning objects and building sentence structure.

3.4.5.2.2. User Account

Although the diagnostic criteria of ASD were determined in DSM-V-TR (American Psychiatric Association, 2013), the characteristics of individuals with ASD differ from each other. While designing a tool to fulfill their needs, such individual differences need to be considered. Therefore, a user account feature was added to the EBA platform so that the application could be specialized in time.

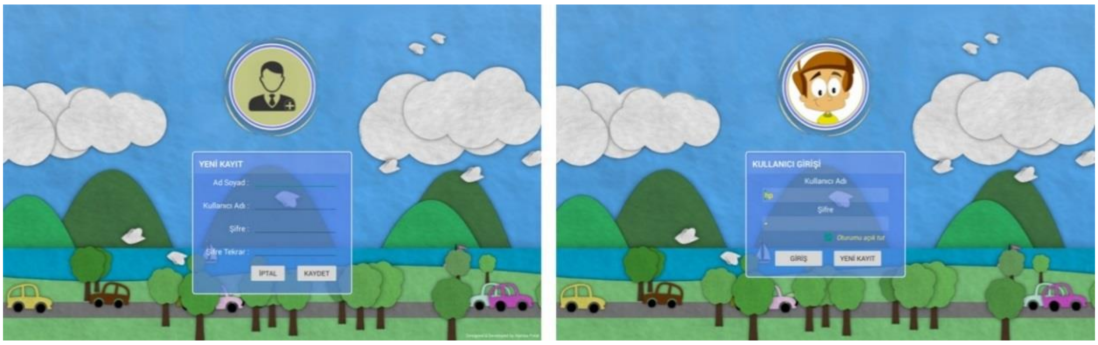


Figure 3.2. Login Screenshot of First Prototype

The EBA demands some information about the user such as name, username, and password. It is also optional to add a profile picture. In order to access the system features, users type their username and password. Once they select the “keep log in” button on the login screen, the EBA remembers the user and his/her predetermined communication objects. By means of that, different users can be able to use the EBA separately.

3.4.5.2.3. Categories

Once the users log in the EBA, the predetermined categories appear on the screen. There are three categories in this screen, which are home, school and free time. These were selected as the by default categories because they were considered as the most frequently used classifications to which communication objects might be inserted.

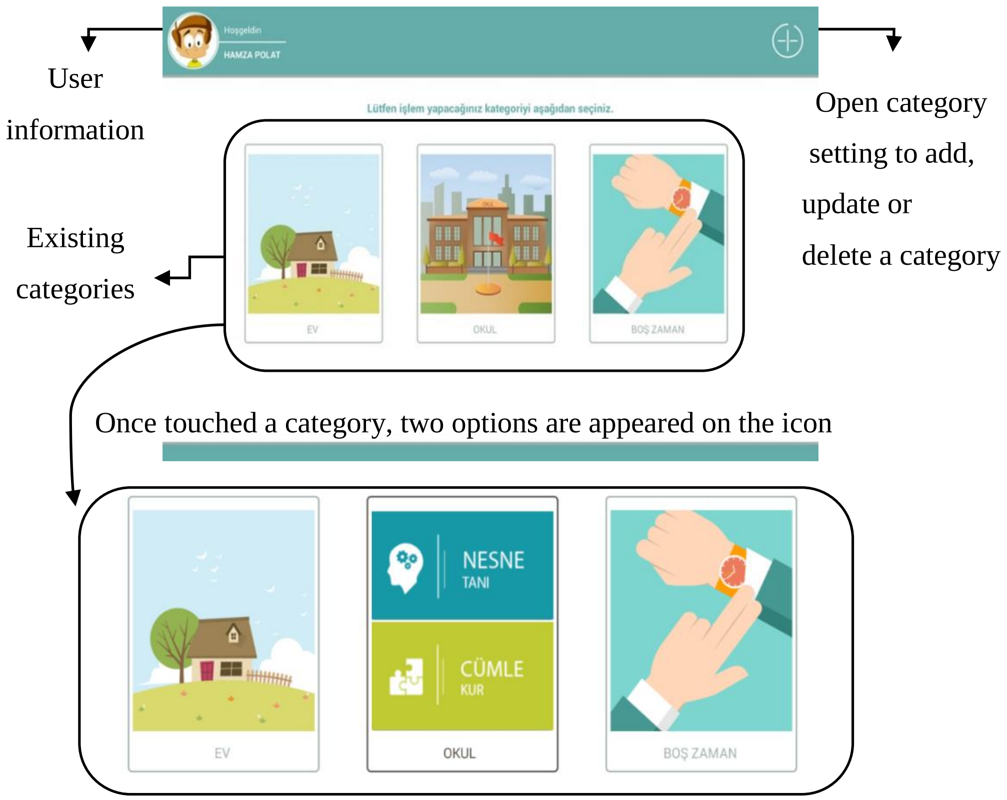


Figure 3.3. Categories Screen of First Prototype

The reason of designing categories screen is to help users to group the communication objects in a related context. For example, when the user wants to collect new objects regarding “school”, then the “school category” can be used. Since the EBA gives priority to the individual differences, the number and the type of categories can be customized by the users. To do so, they need to touch the “category-add” button right-top corner of the screen and then follow the instructions. Each category includes two main facilities, “learning objects” and “building sentence structure”. Once the users touch a category, these two facilities appear in a way that covers the category icon.

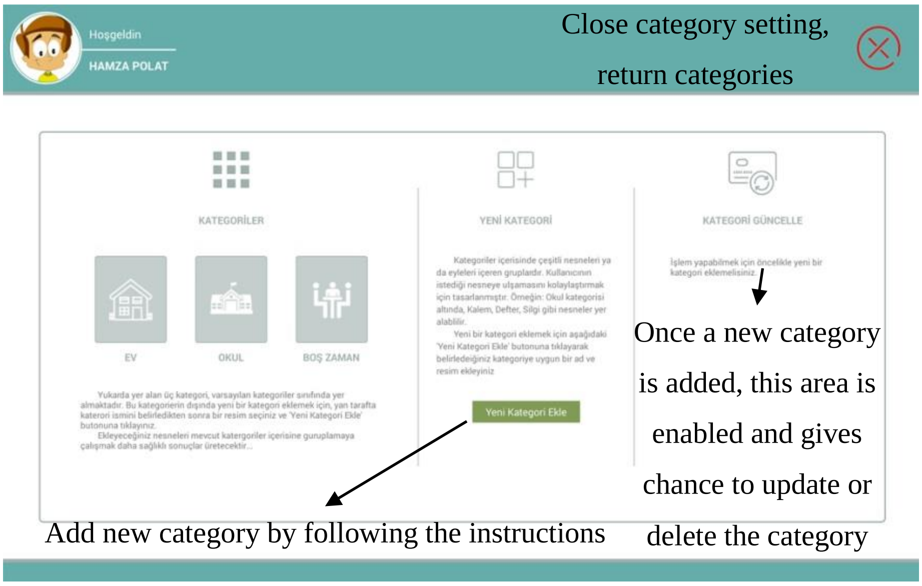


Figure 3.4. Category Setting Screen of First Prototype

3.4.5.2.4. Learning Objects

Learning objects facility was designed to help individuals with ASD to recognize the objects around them. In order to access it, user just touches the category icon (see Figure 3.4) on the categories screen and selects the “Nesne Tanı” option. Once touched, a blank screen encounters the user as shown Figure 3.5. EBA does not provide by default objects for use. Instead, any object that attracts the user’s attention can be added to this part. To do so, user should touch “add object” button, which is at the right-top of the screen. To add a new object, camera and microphone capabilities of mobile devices are used. In order to add objects to this part, first a concrete object is identified. Then, a name that will be taught to the user is given. After that, the image of the object is captured. Finally, a voice record of the object is taken. User can add a variety of object to the EBA depending on the storage on the device. If required, these objects can be updated or deleted.

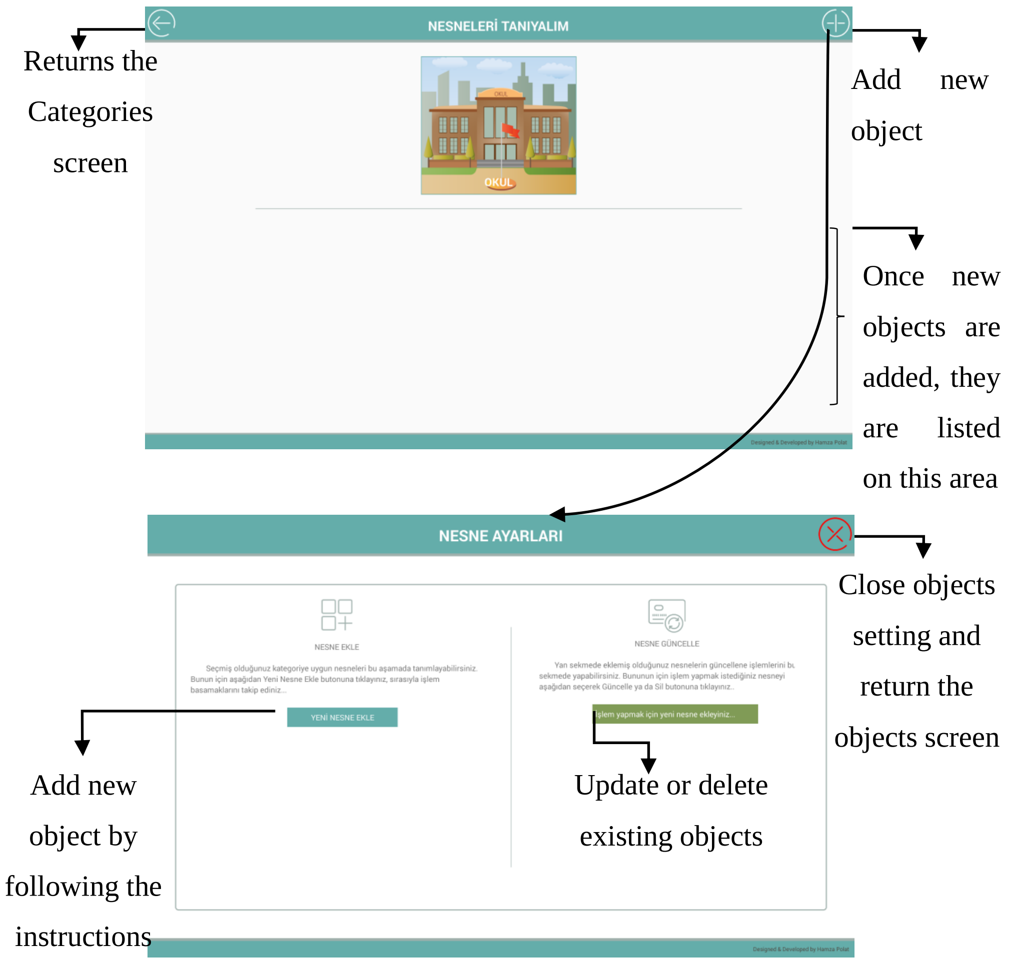


Figure 3.5. Learning Objects and Settings Screen of First Prototype

3.4.5.2.5. Building Sentence Structure

The EBA help individuals with ASD to express what they want. By means of that, it provides an alternative communication way. In order to use this facility, primarily the objects that will be used in communication need to be defined. As mentioned "learning objects" part, EBA does not provide by default objects. New objects can be added to both "learning objects" and "building sentence structure" parts. Both of them also include the same procedure explained previously.

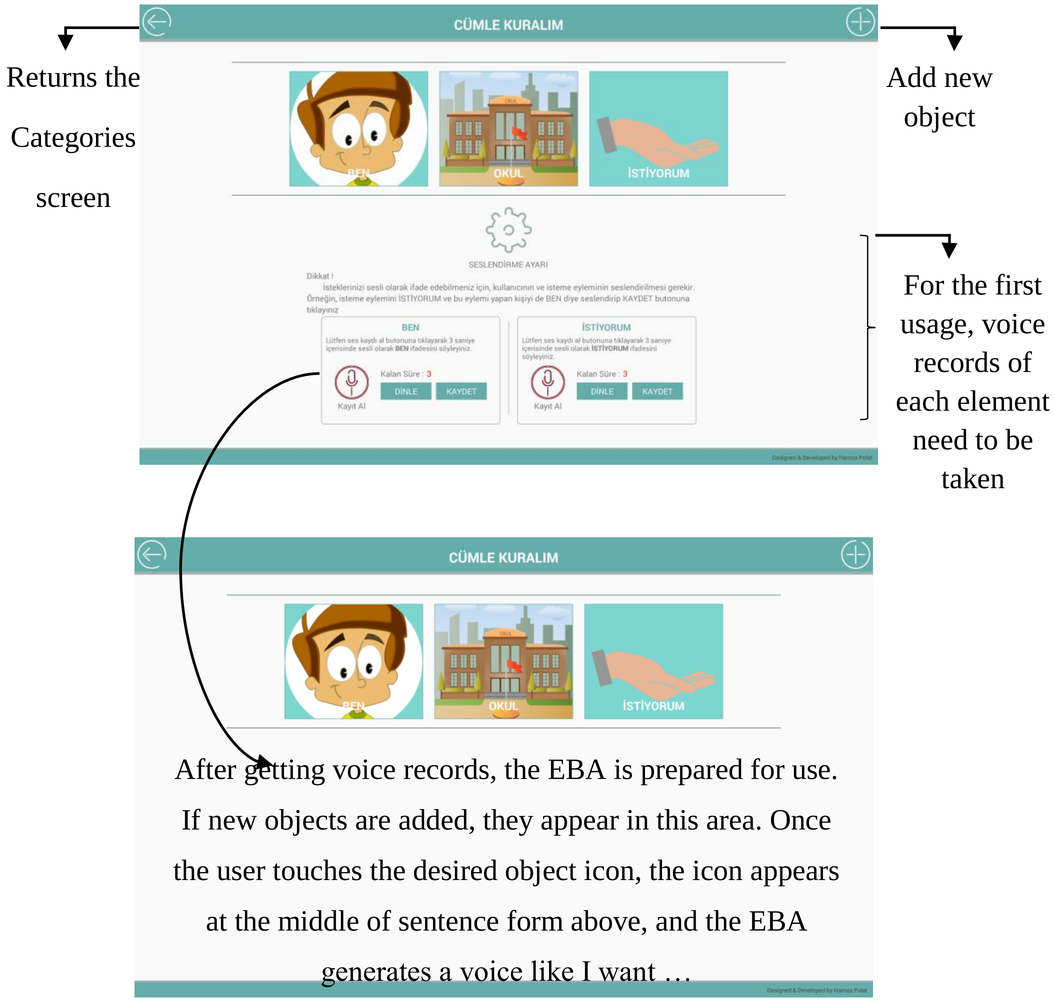


Figure 3.6. Building Sentence Structure Screen of First Prototype

Building sentence structure" aims to use the learned object in a sentence from like "I want …" (Ben … istiyorum). There are three elements of this sentence: subject, verb and the object. The subject represents the user, thus the picture that is taken at the login is used as the subject card. Additionally, in order to illustrate the "verb" in the sentence, an icon about "requesting" was used. Finally, the object of the sentence comes from the learned object part. Once touched the "building sentence structure", the EBA warms user only once to make a voice record of both subject and verb. After completing these tasks, the EBA can be used as a functional communication tool for requesting a desired object.

3.4.5.2.6. Summary of Provided Features in the First Prototype of the EBA

The description of the EBA and its essential features were presented previously in general. These features were listed below:

- EBA provides a platform by which different users can enhance functional communication skills.
- The application runs on Android devices. To get more efficient visual results, tablets with 10.1-inch screen is recommended.
- A user account is required to use the application. In order to register the system, users need to give name-surname, username, and password. It is also optional to add a profile picture. This picture can be captured from the device's cameras or selected from the device's gallery.
- The application recognizes the user information till to sign out from the system. By means of that users do not have to login the system at the beginning of each sessions.
- The application offers three categories by default. These categories can be used to gather related objects.
- If required, users can add new categories to the main page. In order to add a new category, users need to give an appropriate category name and identify a picture that represents the category. The picture can be selected from device's gallery or captured by using device's cameras. Once new categories are added, they are listed at the main page. These categories can be also updated or deleted.
- Category setting page includes help documents in the text format to guide the users.

- Each category provides two features which are “learning objects” and “building sentence structure”. Once touched any category, these features are seen on the selected category icon to force the user to select one of them.

- Once “learning objects” option is selected, the user is directed to a blank page where s/he can learn new objects. This page can be customized by adding, updating or deleting the objects. These operations can be done at objects setting page. In order to add a new object, the user needs to identify an appropriate name, select a picture on the gallery or capture a picture from the camera, and make a voice record of the object in ten seconds. The object setting page also includes help documents in text format.

- Once the object adding procedure is finished, the visual of the object is appeared on the “learning objects” page. Once touched this object, it appears at the top of the page with its name. In the meantime, the device generates the sound recording of the selected object.

- Once the “Building sentence structure” is opened for the first time, the application forces user to make the voice record of both subject and verb. Once these records are made, voice setting icons are disappeared on the page.

- “Building sentence structure” feature includes a Turkish sentence form, which corresponds requesting. The sentence starts with the subject (I) the object (previously added objects) and the verb (want). Each elements of the sentence represents with a visual at the top of the page. Once the previously added object is selected, it appears at the middle of sentence form. In the meantime, the device generates a speech of sentence components. New objects can be added from “building sentence structure” page as well.

- In order to ensure the consistency of the navigation system, the same icons that correspond the related tasks are used. The navigation system was provided as simple as possible and located in a place so that the user does not lose their attention.

3.4.6. Validity and Reliability

To make DBR a scientific inquiry, researchers need to pay more attention to the validity and reliability issues (Design-Based Research Collective, 2003). However, in design based research three are a variety of variables that may affect the problem situation. Therefore, it is not easy to control these variables as in laboratory settings. This is also one of the important arguments about learning that cannot be studied in laboratory settings, but in real life situations (Collins, Joseph, & Bielaczyc, 2004). That is not to say that DBR does not require any strategies to deal with validity and reliability threats. In this regard, while the reliability of results can be increased through triangulation methods, the validity of them can be promoted by iterations and partnerships (Design-Based Research Collective, 2003). In addition to the reliability and validity of the results, it is also critical to ensure valid and reliable instruments during the data collection and analysis process. Because multiple design and research is by nature feature of the DBR (Wang & Hannafin, 2005), valid strategies addressing to the reliability and validity should be employed during the research cycles.

Table 3.5. *Strategies Used to Promote Validity and Reliability of the Results*

Strategy	*Description*
Method Triangulation	Different research methods that may address the research questions were employed.
Source Triangulation	Throughout the process practitioners, teachers, academicians, children with ASD took part in the study.
Analyst Triangulation	Inter-rater agreement strategy was employed while analyzing the qualitative data. Additionally, an instructional technologist reevaluate the case study data in the evaluation phase.

As illustrated at Table 3.5, different research methods were used during the study. In the beginning of the analysis phase a literature review was conducted. An informal market research was accompanied to the literature review. Then, to frame and understand the problem deeply, a focus group study was conducted. Two expert reviews were carried out to seek the design specifications of the AAC applications. Finally, a case study and a pilot study (AB single subject study) was conducted to observe how children with ASD initiate functional communication and make request by using the proposed high-tech AAC application, EBA.

Throughout the process, we made interviews with parents to collect more information about the children with ASD. Additionally, teachers and academicians in special education field made contribution to the study. Finally, 2 children with ASD during the pilot study and 3 children with ASD during the evaluation phase participated to the study. While selecting all of the participants, expertise with and relatedness to the problem situation was taking into account to get rich-information data.

The researcher took the main role in analyzing data. But, to increase the reliability of the results inter-agreement reliability strategy was employed. Especially, after analyzed the focus group qualitative data, the themes and codes with quotations were send two PhD candidates in special education and educational sciences to check the appropriateness of the themes and codes with related to the quotations. Based on their feedbacks, several refinements were made on the themes and codes. Finally, the ultimate version of them was sent to two educational technologists. The inter rater agreement score between initial and evaluated codes was 95%, and initial and evaluated themes was 89.3%.

The case study data, which was gathered during the evaluation phase, was also checked by two instructional technologists. A session from each task implementation was selected randomly. These sessions were evaluated in terms of reliability of codes and procedures. The formula that "(consensus / total response) x 100" was used to calculate inter-observer reliability data of evaluation phase. The criteria that upper than 80% inter-observer reliability data is acceptable in single subjects studies (Tawney & Gast, 1984) was selected in present study. Accordingly, the consensus on inter-observer reliability for codes was 100% and for procedure 98%.

Table 3.6. *Reliability Strategies Throughout the Study*

Strategy	*Analysis*	*Description*
Inter rater agreement	Focus Group Qualitative Data	95 % (initial codes and evaluated codes) 89 % (initial themes and evaluated themes)
Inter observer agreement	Case Study (evaluation phase)	100 % (codes) 98 % (procedural fidelity)

To ensure the validity and reliability of the instruments (see Table 3.7), we used two strategies. Firstly, after first draft of the both focus group and expert review interview protocols were prepared, they were sent two academicians with PhD in special education and educational technology. Based on their feedbacks, the ultimate version of the instruments was prepared. Additionally, the intervention and fidelity forms were prepared according to PECS protocols (Bondy & Frost, 1994).

Table 3.7. *Strategies to Increase Validity and Reliability of the Instruments*

Strategy	*Instrument*	*Description*
Expert Opinion	Focus Group and Interview Protocols	Both focus group and interview protocols were sent a special education expert and an instructional technologist. Based on their feedbacks their ultimate versions were prepared.
Literature	Intervention and procedural fidelity forms	Both of the forms were prepared according to PECS protocols (Bondy & Frost, 1994).

3.5. Current Study in Design Based Research Framework

This part includes the research cycles being employed within the DBR framework. It starts with the analysis of problem situation depending on the special educations teachers' views and continues to the formative and summative evaluation of the proposed AAC application in detail.

3.5.1. Analysis Phase

After deciding to the problem statement, several informal interviews were conducted with a special education expert and an instructional technologist, who are also members of this theses committee. They recommended possible methods that might be used for the communication needs of individuals with ASD. Then, a literature review was conducted to examine the use of such methods in the context. The investigation results lead us to focus on alternative and augmentative technologies, especially assistive technologies. Furthermore, several mobile applications on the official website of the Autism Speaks Organization were also analyzed. This small-scaled market research was narrowed down with the applications that would be used to enhance functional communication of individuals with ASD. For example, an application that is frequently preferred in the world, aacorn, was taken into account. As a national alternative, the application named Tohum 1, which is supported by the Tohum Otizm Vakfı, was also examined within the scope of this research problem. At the end of the market research, it was revealed that there are a variety of AAC mobile technologies supporting English by default language in the world. Even though they support Turkish, due to a variety of differences in grammar between two languages it was not possible to adapt such applications in Turkish context easily. On the other hand, Tohum 1 was designed not only for communication skills but also for several self-care skills and for concept learning. Because of these limitations, it was a requirement to design a new application specialized for communication impairments of individuals with ASD in Turkish context.

After getting ethical approval from the ethical review committee of the Middle East Technical University (Appendix A) and getting permission from the provincial directorate of education (Appendix B), a site visit was made to the Erzincan Special Education Applied Center of Primary Level. An informal meeting in center was organized with the principal and special education teachers to whom the main purpose of the study and the research procedure was explained. Teachers were asked to participate the study voluntarily. Then a consent form was signed by five special education teachers. At the beginning of the study, it was intended to conduct a semi-structured interview individually. But, teachers requested to make interviews together in order to be more helpful. Therefore, a focus group study was administrated with five teachers to understand the characteristics of target group and to identify the essential features of EBA in its natural context.

3.5.1.1. Focus Group Study (Learner Analysis)

Focus group study is a kind of group interview by which the participants not only state what they think, but also how and why they think in a such way about a topic (Kitzinger, 1995; Krueger & Casey, 2015). Contrary to group interview method, participants can ask questions other participants and make contribution to others' views. In this manner, it contributes to explore an unclear topic deeply (Stewart & Shamdasani, 1990). According to Parker and Tritter (2006), the main difference between focus group study and a group interview is the role of researcher. In group interview, the researcher is the administrator who asks question to the participants. In focus group study, on the other hand, researcher is the facilitator who moderates the discussion among the participants. Briefly, what makes focus group different is that while it is difficult to figure out participants' certain thoughts in an individual interview, it could be obtained easily in a group discussion (Kitzinger, 1995).

There are several characteristics of focus group study as are in other research methods. Krueger and Casey (2015) for example, propose five main characteristics of a focus group studies. First, focus group is a kind of group discussion which involves several participants. The number of participants might be change according to research purpose and the resources that are available. The key point here is to adjust the number of participants in a way that include neither a large group in which participants cannot have opportunity to talk nor a small group in which researcher cannot get a diversity of perceptions (Krueger & Casey, 2015). Thus, while some researchers find 4-8 participants adequate (Kitzinger, 1995) others demand 8-12 participants (Stewart & Shamdasani, 1990). Second, the characteristics of participants in the groups should be as similar as possible. The homogeneity of participants is determined according to research purpose. In other words, researcher should pay attention to the participants from which researcher might gather data that he/she needs. Therefore, purposive sampling method is frequently employed to select participants. Third, qualitative data is collected from a focus group study. To do so, moderator asks open ended questions to the participants and discussion session is initiated among them. The environment in which the group sessions are conducted should be comfortable and democratic where participants are encouraged to express themselves clearly. Researcher take tape-records or video-records of discussion among the participants during the sessions. It is also suggested to take notes even if recording is employed (Krueger & Casey, 2015; Patton, 1990). Traditional qualitative data analysis procedures are used in order to analyze the data. Forth, in a focus group study the questions should be selected in a sequence carefully so that participants focus on the discussion. At the beginning of discussion moderator asks simple and more general questions with which the group prepare them to talk and to think about the topic. But, after a while more specific questions are directed to focus on main theme of the discussion. Finally, the discussion helps the researcher to understand the topic deeply. During the discussion sessions, ideas, shares and feeling should not be judged.

Focus group method has wide usage in different disciplines such as health (Basch, 1987; Kitzinger, 1995; Wilkinson, 1998) education (Osborne & Collins, 2001; Parker & Tritter, 2006), and marketing (Wilkinson, 1998) for different purposes. According to Wilkinson (1998), this method is used in three ways: (1) an additional method in multi-method research designs, (2) a primarily method especially in phenomenological research designs, and (3) a form of action research.

Because the aim of this phase was to examine the considerations of special education teachers about the alternative and augmentative communication methods that could be used by individuals with ASD, the data to be collected was mostly qualitative. One of the approaches that commonly used to collect such data is individual interviews. Although, it was intended to conduct individual interviews at the beginning of the study, special education teachers requested to take part in study together. As a result of that, a focus group study was carried out in order to seek insight into considerations of the special education teachers about AAC.

3.5.1.2. Participants

The number of participants might change depending on the research purpose in focus group study. While selecting participants, generally purposive sampling technique is employed. Selected participants should have similar backgrounds (Krueger & Casey, 2015), therefore in a focus group study "homogenous sampling" method is frequently used (Patton, 1990) as a purposeful sampling technique. In this regard, five special education teachers were selected from the Erzincan Special Education Applied Center of Primary Level in current study. The study was conducted in this school due to two main reasons. First, there were merely two state schools where special education students were enrolled in Erzincan province and Erzincan Special Education Applied Center of Primary Level was the only place where student at small ages with ASD can be able to continue their education. Second, all of the instructors at the school were special education teachers. In order to understand the characteristics of children with ASD and to examine special education teachers' considerations about the alternative methods used for communication impairments, we needed special education teacher who had experienced with children with ASD and this center was the most appropriate place in Erzincan. There were three classes at the school, and the class sizes were arranged in way that could not exceeded five students. At least two children with ASD were enrolled to each class. There were four females and a male special education teacher at the school.

Before starting the study, we contacted with the directory of the school with the help of Counselling and Research Center of Erzincan. Then, an informal meeting was arranged with the principals and teachers at the school. The purpose of the study was presented, and we asked them to participate the study voluntarily and all of them accepted to take part in the study.

Table 3.8. *Demographic Information of Participants*

Participants	Gender	Bachelor	Experience in special education
1	Female	Special Education	6 years
2	Female	Special Education	6 years
3	Female	Special Education	3 years
4	Male	Special Education	3 years
5	Female	Special Education	5 years

As illustrated Table 3.8, all of the participants (four females, a male) graduated from department of special education. This is important because, more recently primary school teachers were assigned to special education by taking in-service training for a month in Turkey. Accordingly, all of the participants were familiar to autism concept from the courses they took in their education. Apart from that, expect from forth participant the rest of the participants had experienced with children with ASD while doing their internship. The forth participant, on the other hand, had studied on children with intellectual disabilities in his internship. After graduating, all of the participants started to work as a teacher at Ministry of Education in Turkey. Their experience in special education ranged from three to six years after the graduate. During this period, they faced children with ASD almost every day at school. The total number of children they trained was approximately eight in a year.

3.5.1.3. Instruments

A semi-structured focus group interview protocol was employed in the study to collect data. The interview protocol was created by the researcher in accordance with the research demands (Appendix C). It includes three main sections: introduction, body and conclusion. Introduction section includes guidelines that help moderator to establish a rapport with participants, to explain the purpose of study, and to motivate the participants to talk. The body part of the protocol was structured around the subtopics that involve questions about the individuals with ASD, autism and communication, use of mobile technologies to enhance communication and design issues of mobile technologies for communication. Finally, in conclusion part, the summary of the discussion was provided. The instrument, then, send to an instructional technologist and a special education expert with PhD to evaluate its appropriateness with respect to the first research question. The final form of the instrument was then composed depending on the feedbacks gathered from the experts.

3.5.1.4. Data Collection and Analyze Procedure

In order to conduct focus group study, an appropriate time was arranged by the researcher at Erzincan Special Education Applied Center of Primary Level. We made the meeting at the seminar room of school where all the participants sit around a table. After getting consent forms, researcher as a moderator initiated the discussion by giving chance participants to introduce themselves. Then, the session was managed according to focus group interview protocol. The session last nearly 60 minutes, and the whole-time period was recorded. In addition to tape-recording, several notes also taken to make ease the data transcript process as suggested by Krueger and Casey (2015).

Qualitative data analysis procedure proposed by Corbin and Strauss (2008) was employed to analyze the data. First, the tape-records were transcribed to prepare them for analysis. Second, transcribed document was reviewed to comprehend general sense from the data. Third, the open coding procedure was initialized. In this regard, “codes” are the concepts extracted from the data (Miles & Huberman, 1994) or are the labels researcher gave for the indicators of phenomenon (Corbin & Strauss, 1990). After determining the codes, the axial coding procedure was applied, which is the grouping procedure of concepts or codes into new categories (Corbin & Strauss, 1990) called as themes.

3.5.1.5. Inter-rater Reliability

Inter-rater reliability can be described as the degree of agreement among the coders. To do so, first the themes and codes are extracted from the raw data. Then, the primary version of them was send to two experts who are PhD candidates in educational science and special education. They assessed the appropriateness of codes and themes according to quotations extracted from interview data. Based on the feedbacks gathered from the experts, several arrangements were made on the codes and themes. The ultimate version of codes and themes were send two instructional technologists with PhD to ensure the inter-rater agreement.

Both raters evaluated the appropriateness of codes extracted from raw data and themes related to the codes. They ranked correct codes and themes as 1 and incorrect ones as 0. Firstly, the inter-rater agreement of codes was checked. To do so, the initial codes created by the researcher was compared with the first rater and then with second rater. In order to calculate agreement percentages of first and second rater, their scores then compared as well. As a result, there was a %92 inter-rater agreement between initial codes and first rater codes, %98 inter-rater agreement between initial codes and second rater codes, and %92 inter-rater agreement between first and second rater codes. Based on these results, several refinements were made on the codes and final version of them was provided.

In order to calculate inter-rater agreement of created themes, the same procedure was followed. Accordingly, there were %81 inter-rater agreement between initial themes and first rater themes, %97.6 inter-rater agreement between initial themes and second rater themes, and finally %77 inter-rater agreement between first and second rater themes. Based on these results, several revising was made on the themes to increase the inter-rater reliability.

3.5.2. Design and Development Phases (Prototyping Procedures)

In analysis phase, it was attempted to provide a more valid and effective mobile application with possible features customized for the communication needs of children with ASD. This phase, on the other hand, includes the prototyping procedure of EBA application in general and aims to take EBA a step further in improving its essential features. As previously mentioned, the prototyping procedure was started after reviewing the literature about ASD, AAC and PECS. Then, some of the samples of the AAC applications running on mobile devices in the market was examined. Based on the literature review analysis and market research, the first prototype of the EBA was created.

As indicated before, in analysis phase a focus group study was conducted. The focus group results also contribute to revision of the first prototype. In this manner, not only we collect information about our target group, but also we made revisions on the application according to special education teachers' considerations. As a result of this, the second prototype of the EBA was released.

In the focus group study, we did not illustrate the EBA to special education teachers. In other words, they did not have chance to experience with the EBA at the beginning. Thus, it was a requirement to evaluate it from a point of view that combines theory with practice. To do so, we introduced the EBA to a special education teacher, who is also lecturer of material design course in special education at a state university. He experienced with EBA about an hour and we asked him to take part in the study voluntarily. After signing the consent form, a deeply semi-structured interview was conducted to review the EBA. The interview analysis results lead to make improvements on the EBA.

In order to test the EBA in practice and to observe the children with ASD during the implementation, a pilot study was planned. To do so, an informal meeting was arranged with the teachers in the Erzincan Special Education Applied Center of Primary Level. The target group of this study was discussed and two children with ASD having communication impairments was suggested by teachers. After that, the scope of the study was introduced to the children's parents one by one. We ask them to participate the study voluntarily and a consent form was signed by them. Then, a pilot study was conducted with two children. Finally, by taking the previously conducted expert review analysis results and observation results of pilot study into account, several refinements were made on the EBA, and hereby the third prototype was released. The pilot study also gave chance to the researcher to experience EBA in the field.

Only special education teachers who are familiar to the autism evaluated the EBA application so far. Their considerations contributed EBA to make improvements from a practical aspect. In addition to this, it was a requirement to assess the EBA from theoretical point of view. Thus, the introductory video of the EBA was prepared and uploaded to the YouTube. Then, an online survey including evaluation criteria (Appendix E) of EBA was prepared and sent to the several academicians so that they watch and evaluate the video. Eight of them participated to the survey voluntarily. According to survey results, a few refinements was made on the EBA and accordingly the final product was provided.

Five special education teacher in a state school, an expert in special education and two children with ASD took part in this phase. Additionally, an interview protocol for focus group study and expert review, an observation form, and an online survey were used as an instrument throughout the process. The characteristics of participants and the detail of the instruments explained below.

3.5.2.1. First Cycle: Expert Review

This cycle involves the evaluation of second prototype designed at analysis phase. Previous prototype of the EBA was developed depending on the considerations of special education teachers who did not experienced with EBA. In this cycle, on the other hand, it was attempted to evaluate the EBA by an expert who experienced with the EBA.

3.5.2.1.1. Participants

An expert in special education was participated to the study to evaluate the EBA. To select the participant purposeful sampling method was employed. To do so, firstly an informal visit was made to a special education school in Erzurum province and we introduced the purpose of our study and requested volunteer participants who would be helpful in current study. They forwarded us to a special-education teacher who is also lecturer at a state university. We contacted with the expert and asked him to participate the study voluntarily and a consent form was signed by him. He graduated from department of special education in Turkey. He had experience in special education about ten years, and he had encountered at least a child with ASD every year. Additionally, he was also interested in congress in special education activities and participated some of them. Consequently, he was familiar with autism and children with ASD.

3.5.2.1.2. Instrument

In order to conduct an expert review, firstly a semi-structured interview protocol (Appendix D) was prepared. The protocol includes ten open ended questions. The questions were prepared by considering the following issues:

- Appropriateness of EBA for the intended purpose
- Appropriateness of EBA for the target group
- Content of the EBA
- Additional features that could be on the EBA

- The interface of the EBA
- Colors used on the application
- Texts used on the application
- The navigation system used in the application
- Favorable features of the EBA
- Undesirable features of the EBA

While developing the instrument, not only the user interface of the EBA was taking into account, but the logic behind the EBA was requested as well. The instrument then sent to two instructional technologists to ensure its validity. Based on the feedbacks, several refinements were made on the interview protocol.

3.5.2.1.3. Data Collection and Analyze Procedure

To conduct the interview, an appropriate time and place was arranged. Firstly, the purpose of the study was explained and then, all the features of the EBA was introduced to the expert. After that, the expert experienced with the EBA for a while. During this time, he asked some questions about the application. After he experienced with EBA and find adequate answers to the questions about the structure and implementation of EBA, the interview was started. Tape-recording was used during the interview.

In order to analyze the data, qualitative data analysis procedure proposed by Corbin and Strauss (2008) was employed. In other words, firstly the tape-records was transcribed. Then, open and axial coding procedure was employed.

3.5.2.2. Second Cycle: Pilot Study

The EBA application was created based on the arguments in the literature. Then, special education teachers' considerations were taken to make the EBA more valid.

Finally, an expert in the field reviewed the EBA and offered some suggestions about the structure of the EBA. In this cycle, the EBA was tested in the field with two children with ASD. In this section, participants of the pilot study, implantation procedure and instruments used in pilot study was provided.

3.5.2.2.1. Dependent and Independent Variables

In pilot study, the main purpose was to investigate how children with ASD request a desired object while using EBA. Therefore, dependent variable was “requesting a desired object”, on the other hand, the independent variable was “instruction with EBA”. The instruction procedure started with a child sting on a table, a communication partner opposite the child, and a physical prompter behind the child.

3.5.2.2.2. Participants

Two children (a male and a female) with ASD were participated to the pilot study. To select the participants, purposeful sampling technique was employed. In doing so, a site-visit was made to the Erzincan Special Education Applied Center of Primary Level. There were 12 children who diagnosed with different disorders in the center. Two children with ASD were selected among them. While selecting the participants, four main criteria were taking into account. First participants had to be diagnosed with ASD. Second, they had to possess communication impairments that is lack of expressive language. Third, they had to follow simple instructions when they are told. And finally, they had to be at small ages.

After selecting the children, we contact with each children’s family and introduced the purpose of the study. They gave permission to include their children to study voluntarily and signed the consent forms. The characteristics of the children were provided Table 3.9.

Both of the children were at seven years and were diagnosed with ASD. As indicated DSM-V, ASD involves three types which are autism, atypical autism and Asperger syndrome. In this study, while the first child was diagnosed with autism, the second one was atypical autism. They had three main communication skills according to their medical report. First, they could be able to pay attention towards a speaking person. Second, both of the children could recognize their families. Third, they could be able to perform an act when they were told.

Table 3.9. *Demographic Information of Participants in Pilot Study*

Participants	Gender	Age	Diagnosis	Communication Skills
1	Male	7	ASD	Direct attention to the ones speaking, recognize his/her family, follow the instructions requiring just one act
2	Female	7	ASD	

3.5.2.2.3. Implementation Procedure

Skinner (1957) argues that the communication act starts with learning requesting something. In this point, it so important to know what a child actually wants. The objects mostly desired by the child give insight to carry out the study on them. Therefore, at the beginning of the study, a reinforcement form (see Appendix K) was filled for each child. To identify the possible reinforcements, opinions of both teachers and parents are taken.

Although we may know possible desired object from reinforcement form, we still do not decide what children will want during the actual implementation. Thus, a preference assessment should be done to find out the desired object. In this regard, possible reinforcements (objects) are spread out in front of the child. Then, to learn the desired object, they are observed for a while. Most probably the child starts to play or be interested with the objects she/he wants. These objects are put in front of the child, and then the child is asked to select one of them. The locations of the objects are changed at each trial. The object which is selected for three times in succession is called as the “desired object”. In this regard, in the pilot study the preference assessment was conducted for each child to identify the desired object. Accordingly, the first child selected yoghurt with fruit and the second child selected a mini chocolate bar. Requesting procedure of desired objects were initiated on these objects.

Table 3.10. *Time Schedule of Pilot Study*

Participants	Session No	Reinforcement	Session Type	Date
1	1	Fruit Yogurt	Intervention	31.05.2017
	2	Fruit Yogurt		01.06.2017
	3	Fruit Yogurt		02.06.2017
2	1	Chocolate Bar		31.05.2017
	2	Chocolate Bar		01.06.2017
	3	Chocolate Bar		02.06.2017

A similar procedure of PECS protocols was followed to teach the EBA to the children with ASD. This procedure was managed with a child who has communication impairment and two assistances. The first assistance called as “communication partner” with whom the child initiate communication. The other assistant, on the other hand, is called as “physical prompter” who physically helps the child to accomplish the communication act. In current study, special education teacher was assigned as the communication partner and the researcher was physical prompter.

Three session with each child were carried out in pilot study. At the beginning of each session a preference assessment was carried out. In doing so, each child was observed in terms of how they request the desired object in front of them. Because they have lack of expressive language by nature, any communication act was not observed at the beginning. After that, the intervention session was started. During the intervention session, participants and the communication partner sit a table face to face. The physical prompter stayed behind the participant to help the child. A user account for each child was created on the EBA application. The picture of the desired object was captured and its record was taken by using the EBA. The EBA account was opened and the tablet was put in front of the child. On the other side, the desired object was put in front of the communication partner. When the child attempted to get the desired object, the physical prompter guided the child to touch the picture of the object on the tablet. As soon as the child touches the picture, the communication partner gave the object to child suddenly with a vocal prompt of “you wanted this”. This procedure was repeated till to child learned how to get desired object. During this process, the location of the tablet on the table was changed as well. After the intervention sessions, participants were observed how they requested the desired object. While doing that, it was expected from the children to initiate the communication act, requesting, without getting physical prompts. Each session was recorded with a camera and task analysis procedure was employed to analyze the data.

3.5.2.2.4. Task Analysis Procedure

As indicated evaluation phase, tasks analysis is frequently used method in special education to analyze a particular behavior or a skill. While doing that, target tasks are identified in advance, and then these tasks are broken into pieces to get subtasks. In pilot study, “requesting a desired object” was selected as the main task, and to assess this task the following subtasks presented on the Table 3.11 were determined depending on literature.

Table 3.11. *Task Analysis: Steps for Implementation in Pilot Study*

Main Task	Step No	Subtasks
	1	Sit down in front of a communication partner on a table.

	2	Touch the desired object's picture on the tablet located in front of the child.
Teaching use of EBA for requesting via Physically Assistance	1	Sit down in front of a communication partner on the table
	2	Touch the desired object's picture on the tablet *located different place* on the table.

As indicated the Table 3.11, the main task was divided into two pieces that includes two steps. Both of the subtasks were occurred in a special education class where the child and the communication partner sit face to face. But, the location of the tablet was changed to initiate spontaneous requesting by the child.

3.5.2.2.5. Data Collection and Analysis

The main purpose of the pilot study was to test EBA in the real context and if required to make methodological changes on the real implementation based on the observations during the pilot study. For that purpose, an observation form (Appendix L) was prepared according subtasks provided above. The observation merely focuses on the target behavior, so that it allowed us to check whether children reached the target task or not. To do so, children were taken to an appropriate place in the Erzincan Special Education Applied Center of Primary Level for the treatment one by one. The implementation procedure previously provided was employed and video-record of each session was taken. The observation data was collected by the researcher after watching each video record.

Apart from data related to the target behavior, the implementation procedure also observed in terms of fidelity of the implementation. In this study, the treatment procedure was designed in a way that did not include verbal prompts like "if you want this, touch that icon". However, in this study teacher as a communication partner used verbal prompts. This mistake was determined by the theses committee while watching the pilot study sessions. Then, we noted this issue and for the real implementation teachers were warmed to pay attention to the implementation protocols.

Analysis results were presented with visual line graphs. Presented data gave insight into effectiveness of the implementation after the treatment. In order to present the pilot study data, visual graphs with statistical expressions were provided. The results of the pilot study were presented at the results section.

3.5.2.3. Third Cycle: Expert Review

The expert review previously conducted aimed to make formative evaluation of the EBA from a practical point of view. Then a pilot study was carried out to test the implementation protocols of EBA. Several refinements were made on the EBA and third prototype was released based on the results of both first expert review and pilot study. In this cycle, on the other hand, it was intended to make a new formative evolution of the EBA from an academic point of view. To do so, an introductory video of the EBA was prepared, which includes the essential features and the use of EBA. Then, this video was uploaded to YouTube. After that, an online survey prepared based on the questions of first expert review. The survey and the YouTube link of the EBA were send to academicians in the different special education departments. Finally, the EBA was improved according to feedbacks gathered from the academicians.

3.5.2.3.1. Participants

Three female and five male academicians in special education field were participated to final formative evaluation of the EBA. In order to select participants, purposeful sampling method was employed. Researcher contacted with academicians in four special education department in Turkey to participate the study voluntarily and eight of them positively returned to our request. The demographic information of the participants provided on Table 3.12.

Table 3.12. *Demographic Information of Participants in Final Expert Review*

Participants	Gender	Bachelor's Degree	Educational Status	Experience in Special Education
1	Female	Mental Disabilities Education	Master	3 years
2	Female	Special Education	PhD	7 years
3	Male	Classroom Instruction Education	Master	5 years
4	Male	Special Education	Master	7 years
5	Male	Special Education	PhD	20 years
6	Male	Mental Disabilities Education	Master	8 years
7	Female	Mental Disabilities Education	Master	10 years
8	Male	Mental Disabilities Education	Master	3 years

As indicated Table 3.12, seven participants took their undergraduate degree from special education departments. Because the departments related to the special education have merged under the name of special education in Turkey since 2015, the department of mentally dishabilles is also categorized under the special education department. One participant, graduated from the department of classroom instruction department. But, all of the participants are working in special education currently. While two of the participants had PhD degree, the others had master degree, but PhD candidate. Their experience in special education ranged from three to twenty years.

3.5.2.3.2. Instruments

An online survey (Appendix E) was used to collect data. While creating the survey, an online free Web 2.0 tool was used. The survey included four sections; consent form, the demographic information part, rating scale with open-ended questions, and merely open-ended questions. In the first part of the instrument, the purpose of the study was introduced and an approval was requested from the participant to participate the study voluntarily. In demographic information part, questions about the characteristics of participants were provided such as gender, bachelor degree, educational status and experience in special education. In the third part, seven 5 point Likert scale (1: strongly disagree, 5: strongly agree) were used. In order to ensure the consistency between the first expert review and the second one, the same questions were asked in the form of rating scale. But, an open-ended sub-question was attached to each question to get explanation for the cases that participants give lower scores to the questions. By means of the sub-questions, it was intended to take the opinions of participants in order to enhance the capabilities of the EBA. The last part of the instrument just includes six open-ended questions which are the same questions of instrument employed in first expert review except the last one.

While preparing the instrument, our priority was to maintain the consistency in method between first and the second expert review. Therefore, the same questions were used in the second instrument. But, the form of questions was reorganized after getting feedback from two instructional technologists with PhD. Based on their opinions, the first seven questions were provided in Likert type and an open-ended question was attached to each question as a sub-question. Finally, the thirteenth question was added to instrument to understand the general considerations of participants about the EBA.

3.5.2.3.3. Data Collection and Analysis

The second expert review focuses on the formative evaluation of EBA from academicians at special education department. However, there was no a special education department at Erzincan Province where the study is conducted. Therefore, we contacted with the special education departments at four different universities in Turkey with the help of thesis committee members. Because the 2017 spring season was over in Turkey, almost all the participants were at vocations. Therefore, it became a requirement to reach them remotely. To do so, an introductory video of the EBA consisting of 26 minutes was prepared. The video was controlled whether it represented the main characteristics of the EBA with an instructional technologist, then uploaded to a video sharing website (YouTube). The link of both online instrument detailed at previous section and the introductory video was shared with the academicians. In order to collect data, it was expected from the participants to watch the video at the beginning, then to answer the questions on the online instrument based on their virtual experience with EBA.

In this section, the data was both qualitative and quantitative. The qualitative part of the data was almost descriptive, thus to analyze such data descriptive statistical analysis were used. In order to analyze the qualitative part, on the other hand, qualitative data analysis procedure was employed. Firstly, codes from the raw data, then themes were elicited from the codes. Both qualitative and quantitative data were used to make ultimate refinements on the EBA.

3.5.3. Evaluation Phase

The main purpose of the evaluation phase is to examine the validation of EBA in the context. To do so, researcher got an appointment from Erzincan Counseling and Research Center to select the children who would be able to participate the study based on the criteria that are previously determined from the literature by researcher. Because early diagnosis and treatment are so crucial in special education, children with ASD at small ages were the primary target of current study. Therefore, five children with ASD between 4 to 7 were selected with the help of officials in the center. Thanks to officials in the center we got in contact with the families of each child. We made home-visit to each family to inform the concept of the study and to motivate them to take part in the study. Actually, all of the families stated their pleasures and they signed the parent permission forms (Appendix I).

Because selected children had disabled-report from counseling and research center they had right to get special training till to eight hours from private rehabilitation centers. Therefore, we contacted with the rehabilitation center where children continued regularly. We also got permission for the implementation of EBA in their center. As a result, three rehabilitation centers accepted the implementation of EBA in their centers and two sessions in a week for each child were arranged. Each session included maximum 10 minutes that was appended children's normal study period. Researcher, special education teachers and sometimes parents participated to each session that lasted eight weeks. At the beginning of the sessions, the use of the EBA was taught to each child, then data regarding how they initiate communication was collected through observation forms. The detail of evaluation phase explained below.

3.5.3.1. Summative Evaluation of EBA

Multiple research methods are the intrinsic nature of DBR. In evaluation phase of the study, therefore, the ultimate version of the EBA was tested in the field. In doing so, participants were separately observed in terms how they initiate functional communication, more specifically requesting.

3.5.3.1.1. Dependent and Independent Variables

The main purpose of the EBA implementation is to teach functional communication skills to the children with ASD. The first step of functional communication is the "request", in other words "mand", to a desired object (Skinner, 1957). There are also nonverbal acts of a healthy communication. One of them is the physical orientation towards to communication partner.

As illustrated Table 3.13, dependent variables of this study are (1) physical orientation toward to communication partner and (2) requesting a desirable object. On the other hand, the independent variable is the instruction with EBA mobile application.

Table 3.13. *Dependent and Independent Variables*

Dependent Variables	Independent Variable
Physical Orientation toward the communication partner Requesting a desirable object	Instruction with EBA application

3.5.3.1.2. Task Analysis Procedure

Task analysis is frequently used method in special education to teach and evaluate a target behavior or skill. It is preferred because it helps to identify and to sequence task components directly related to the target behavior (Knapczyk, 1975). In other words, firstly the target behaviors or skills are identified, and then they are broken into pieces that would be taught gradually (Carter & Kemp, 1996). There are different implementations of task analysis. Component task analysis is one of these analyses and focuses on tasks that involve observable skills which would be divided into subskills (Carter & Kemp, 1996). By this way, instead of completing the whole task at once, individuals perform the subskills one by one. In component task analysis, subtasks can be identified not only by observing the learners in context (Moyer & Dardig, 1978), but also by gathering information from an expert (Schuster & Griffen, 1990) in the field. According to Carter and Kemp (1996), this analysis is more suitable to the tasks that require motor and academic skills in special education.

Moyer and Dardig (1978) proposed several guidelines to carry out a task analysis for practitioners. According to them, first the main task should be manageable that should not be broad-based. If the task might be out of control of the executive, then it should be divided into small main pieces. Second, sub-task should be behavior-oriented. Different raters can be able to easily evaluate the sub-tasks. Third, tasks should be written in an appropriate terminology that could be understood by the evaluators. Forth, tasks should be written down in the format that includes what the learner will do. Finally, although it is important to take into account the characteristics of the population to which the tasks are prepared, researcher should focus on the target behavior. That is, individual differences of each participant should not dominate the tasks.

In this study, the instruction procedure includes task and subtasks to be accomplished by the children with ASD. Task analysis procedure was prepared according to guidelines proposed by Moyer and Dardig (1978). Because the ultimate goal of current study was to teach functional communication to target group, functional communication was selected as the main task to be accomplished. Functional communication is a wide-scale task that necessitates several subtasks. Therefore, the main task was divided into pieces depending on the PECS protocols proposed by Bondy and Frost (1994) and was adapted to the problem situation. Then, an instruction is planned on and made with the participants to test the applicability of tasks in practice at the pilot study. Then, several arrangements were made on the tasks based on the observations on the pilot study. Finally, tasks were put into final form in accordance with the suggestions of a special education teacher who participated to the pilot study. The final form of the tasks was presented at Table 3.14.

Table 3.14. *Task Analysis: Steps for Implementation*

Main Task	Step No	Subtasks
1. Use of EBA for requesting via Physically Assistance	1	Sit down in front of a communication partner on a table.
	2	Touch the desired object's picture on the tablet located in front of the child.
	1	Sit down in front of a communication partner on the table

	2	Touch the desired object's picture on the tablet *located different place* on the table.
1. Spontaneous use of EBA	1	Hold the tablet from a *different place on the room*.
	2	Approach the communication partner sitting on the table with the tablet
	3	Touch the desired object's picture on the tablet
	1	Hold the tablet from a different place on the room.
	2	Approach the communication partner waiting a *different place* in the room.
	3	Touch the desired object's picture on the tablet
	1	Hold the tablet from a different place on the room.
	2	Approach a *different communication* partner waiting a different place in the room.
	3	Touch the desired object's picture on the tablet.
2. Simultaneous simple discrimination of pictures	1	Hold the tablet from a different place on the room.
	2	Approach the communication partner waiting a different place on the room.
	3	Discriminate the desired object between *two pictures* (one is contextually appropriate, the other one is non-preferred) on the tablet and touch it.
	1	Hold the tablet from a different place on the room.

	2	Approach a *different* communication partner waiting a different place on the room
	3	Discriminate the desired object between two pictures (one is contextually appropriate, the other one is non-preferred) on the tablet and touch it.
	1	Hold the tablet from a different place on the room.
	2	Approach a different communication partner waiting a different place on the room
	3	Discriminate the desired object *among three or more pictures* (one is contextually appropriate, the others are non-preferred) on the tablet and touch it.
3. Simultaneous conditional discrimination of pictures	1	Hold the tablet from a different place on the room.
	2	Approach a different communication partner waiting a different place on the room.
	3	Discriminate the desired object between *two pictures* (*both of the objects are contextually appropriate*) and touch it.
	1	Hold the tablet from a different place on the room.
	2	Approach a different communication partner waiting a different place on the room.
	3	Discriminate the desired object *among three or more* pictures (*all of the objects are contextually appropriate*) and touch it.

4.	Sentences Structure	1	Hold the tablet from a place on the room.
		2	Approach any communication partner waiting a different place on the room.
		3	Select the sentence structure icon on the tablet screen
		4	Discriminate the desired object among several pictures and touch it.

3.5.3.1.3. Participants

In this section the characteristics of the participants and inclusion criteria were provided.

3.5.3.1.3.1. Selection of Participants

The main purpose of the study was to enhance the communication skills of individuals with ASD. Therefore, the first criterion being used to select participants was to reach children with ASD. The second criterion was that they should be at small ages because they are more likely to respond the treatment at small ages. In addition to selection criteria several prerequisite skills were identified as presented on Table 3.15.

During the implementation of EBA, a similar procedure with PECS was used. Because the implementation of PECS protocol does not require eye-contact, imitation, and matching at the beginning (Bondy & Frost, 1994), these skills were not taken into account for the implementation of EBA.

In order to select the participants, firstly we contact with the counseling and research center of Erzincan where all the individuals with disabilities were followed. They suggested five children who could be take part in the study based on selection criteria. Then, with the help of the center, we contact with the families of each child. In order to introduce the study and to take their consent for participation in study, a home-visit was made to each family. They signed the consent form and state their pleasures. A demographic information and a reinforcement form were filled by the parents.

Table 3.15. *Prerequisite Skills to Select the Participants*

No	Prerequisite Skills
1	Can be able to follow verbal instruction (E.g., look, go, come etc.)
2	Can be able to focus on a task for a while
3	Can be able to use his/her hands and fingers
4	Having communication impairments
5	Cannot be uncomfortable during the implementation

During the home-visits, we acquainted with each child. Additionally, parents filled a form including prerequisite skills of their child. Although, counseling and research center suggested five children, two of them did not fulfill the prerequisite skills. Therefore, the rest three children with ASD were selected in current study. While selecting the participants purposive sampling method was employed.

3.5.3.1.3.2. Characteristics of Participants

The participants of the current study consist of three male children with ASD. While two of them went to kindergarten, the other one went to primary school regularly. Their ages ranged from four to seven. Their names were kept private throughout the study and predetermined codes were assigned to each child. Accordingly, the codes were EB, HC and OFK. Demographic information and characteristics of each participant and their parents were presented Table 3.16, Table 3.17 and Table 3.18.

The first participant, EB, was four years old male who diagnosed with ASD. His disability level was 40%. The time when he took part in this study he was going to kindergarten for a month and he has continued to rehabilitation center for a year. According to his family, he has good relations and has tendency to communicate with his family. But when he did not get what he wants, he shows undesired behaviors like crying. To some extent he could be able to make eye-contact with his family. His mother was 38 years old housewife and had middle school degree. His father, on the other hand, was 39 years old. He had high school degree and was working as an accounted in a private company. EB had one sister at 13 and there were no any disabilities at her. The family expressed their economic status at middle level.

Table 3.16. *Demographic Information of Participants*

Code	Gender	Age	Diagnosis	Disability Rate	Additional Obstacle
EB	Male	4.5	ASD	% 40	No
HC	Male	6.5	ASD	% 40	No
OFK	Male	4.5	ASD	% 70	No

Table 3.17. *Educational Background of Participants*

Code	Attention Time to Rehabilitation Center	Weekly Attendance to Rehabilitation Center	Formal Training Institutions
EB	1 year	Twice a week / 45 mins.	Kindergarten
HC	2 year	Twice a week / 45 mins.	Primary School
OFK	1 year	Twice a week / 45 mins.	Kindergarten

Table 3.18. *Demographic Information of Families*

Code	Age of Father	Occupation of Father	Father's Education	Age of Mother	Occupation of Mother	Mother's Education	Age of Siblings
EB	39	Accounted	High School	38	Housewife	Middle School	13

HC	38	Trader	High School	31	Housewife	High School	-
OFK	37	Trader	University	38	Housewife	High School	11

HC was seven years old male with ASD. His disability level was 40%. He was going to Erzincan Special Education Applied Center of Primary Level and the rehabilitation center for two years. According to his father, he plays games and has good relations with his family. Although, he tends to communicate with his family, he does not express himself. He is so sensitive for external noises and shows undesired behaviors very much. Especially, when he thinks that his family does not understand what he needs, he exhibits such behaviors. For example, since he did not want to go to swim, he strayed at his home a month ago. According to his family he could be able to make eye-contact when he wants. His mother was 31 years old housewife and graduated from high school. His father was 38 years old trader and had high school degree. He had not a brother or sister due to the family's drawback about a child that might be the same situation of HC. His family stated their economic status as middle level.

Finally, OFK was four years old male with ASD. His disability level was 70%. He has been continuing to rehabilitation center for a year. At the beginning of this semester he started to kindergarten as well. According to his mother, he could be able to set up games with his family. Especially, when he needs help, he tends to communicate with his family. He could make eye contact spontaneously, but when someone wants to make eye contact with him, he denies to do. His mother was 38 years old housewife and graduated from high school. She is also closely interested with OFK in his education. Although, she did not have any special education background, she is aware of how to train her child. His father, on the other hand, was 37 years old and had undergraduate degree. He was working in a private company and frequently going out of the town. OFK has a brother who was 11 years old and had not any disabilities. The family also expressed their economic status at middle level.

3.5.3.1.4. Settings (Context)

The study was conducted at special education classes of the rehabilitation centers where the participants continued regularly (see Figure 3.7, Figure 3.8 and Figure 3.9). A traditional class at the centers generally included a table and two chairs. During the implementation, a video camera also used to take the records of each session. The camera was located in an appropriate place in the class in order not to disturb the participants. The EBA application was presented to children on a tablet. The technical properties of the tablet were provided at the Appendix N. Researcher, special education teachers, sometimes children's parents and internships were involved in the class during the implementation. The study was conducted in accordance with the predetermined task analysis steps.

Figure 3.7. Intervention Sessions with EB

Figure 3.8. Intervention Sessions with HC

Figure 3.9. Intervention Sessions with OFK

The main material used in the setting was the EBA application. The application was designed to enhance communication needs of individuals with ASD. Because the current study also focused on the design process of the EBA, certain features of the application was emerged within the on-going development process. Thus, the detail of the EBA was presented at results section of the current study.

3.5.3.1.5. Instruments

A demographic information, a reinforcement and an observation form was used to collect data. The demographic information form (Appendix J) included two sections: characteristics of participants and their families, and prerequisite skills. The first section of the form consisted of questions about characteristics of participants, educational status of participants, information about communication impairments, and characteristics of participants' families. The second part, on the other hand, included five prerequisite skills (see Table 3.15). These skills were identified based on the related studies in the literature. Firstly, the implementation of the EBA started with a preference assessment. To complete the preference assessment, children should be able to follow simple instructions like "Look here, and take one of them". Secondly, attention deficient is a commonly seen symptom of autism. Therefore, it was crucial to select participants who could be able to pay attention to the predetermined tasks for a while during the implementation. Thirdly, the EBA was designed for tablet computers. Participants using the EBA should be able to use their hands and fingers to accomplish the EBA tasks. Fourthly, as emphasized previously, EBA provides an alternative way for the individuals who possess communication impairments. Thus, children who do not have lack of communication and who already use any AAC are not scope of this study. Finally, obsessive behaviors are frequently seen disorder at autism. Thus, participants should not be uncomfortable during the implementation.

The reinforcement form (Appendix K) was used to collect data before the implementation of EBA. The form included possible reinforcement to be used as a desired object for children. It also included open ended questions to identify undetermined reinforcements.

The observation form (Appendix L and M) was prepared to investigate the second research question of the study. Therefore, it included checklists that included items prepared according to task analysis (see Table 3.14). As mentioned at the task analysis procedure, tasks were elicited from the literature.

3.5.3.1.6. Treatment Procedure

After identifying the participants, we got parent permission form of each child (Appendix I). Additionally, a demographic information form (Appendix J) and a reinforcement form (Appendix K) was filled by the parents. Then, we contacted with the rehabilitation center where the participants have continued regularly. We got their permission to carry out the study on their center. It was decided to append the sessions to last ten minutes of each lecture that students took at the rehabilitation center. Each session was carried out with the researcher and special education teachers at the class. Sometimes, parents and interns participated to the sessions as an observer. Throughout the study, intervention session and follow-up sessions were conducted and recorded by a camera to observe the communication acts of each child. The communication acts included the fundamental functional communication variables that requesting an object (mand) independently and performing non-verbal communication behaviors, which is physical orientation toward the communication partner. The whole process was illustrated at Figure 3.10.

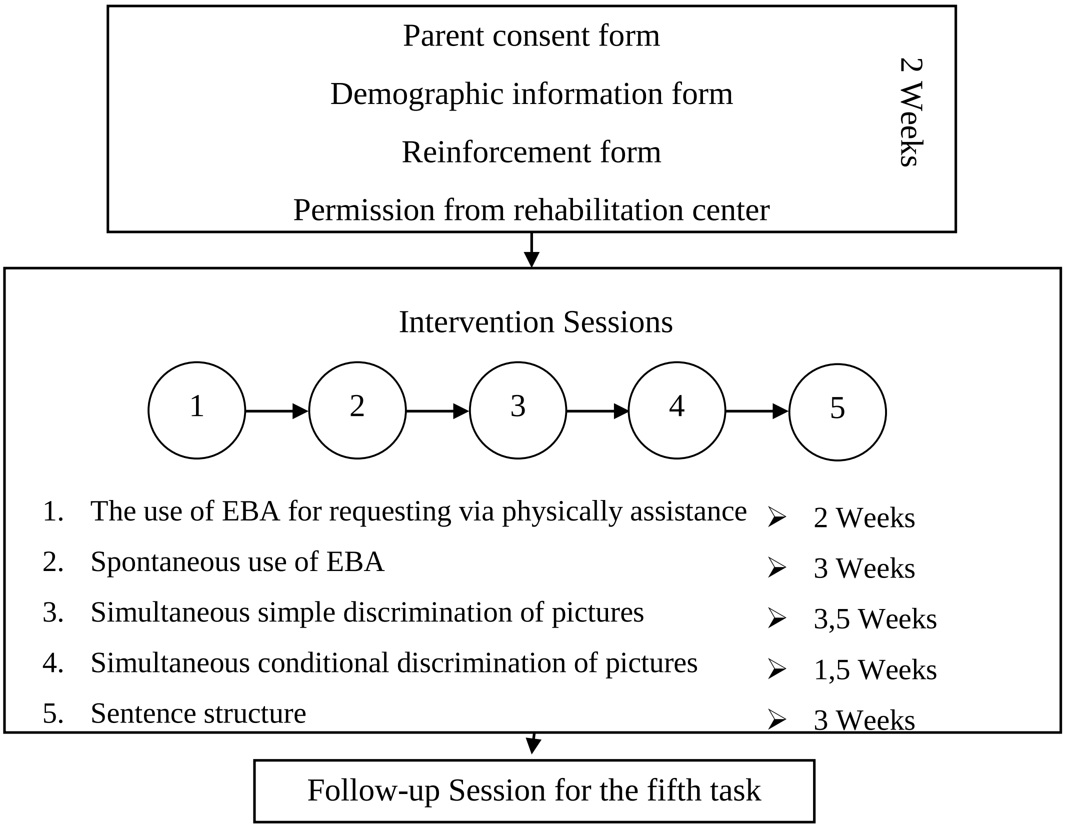


Figure 3.10. The Flowchart of Intervention Sessions

Before starting to the study, a preference assessment (see Figure 3.11) needs to be done with each child. A preference procedure is a test by which researcher tries to understand which objects children actually desire to get. There is a variety way of doing such assessment but the simple way to identify the desired objects is just spreading the several objects in front of the child and giving chance to select one of them. In essence, attempts pointing to the same object more than two times, give clear clue that the child tend to get the desired object. After identifying the desired- object, other objects were removed in front of the child. The rest of the study was preceded with the selected object.

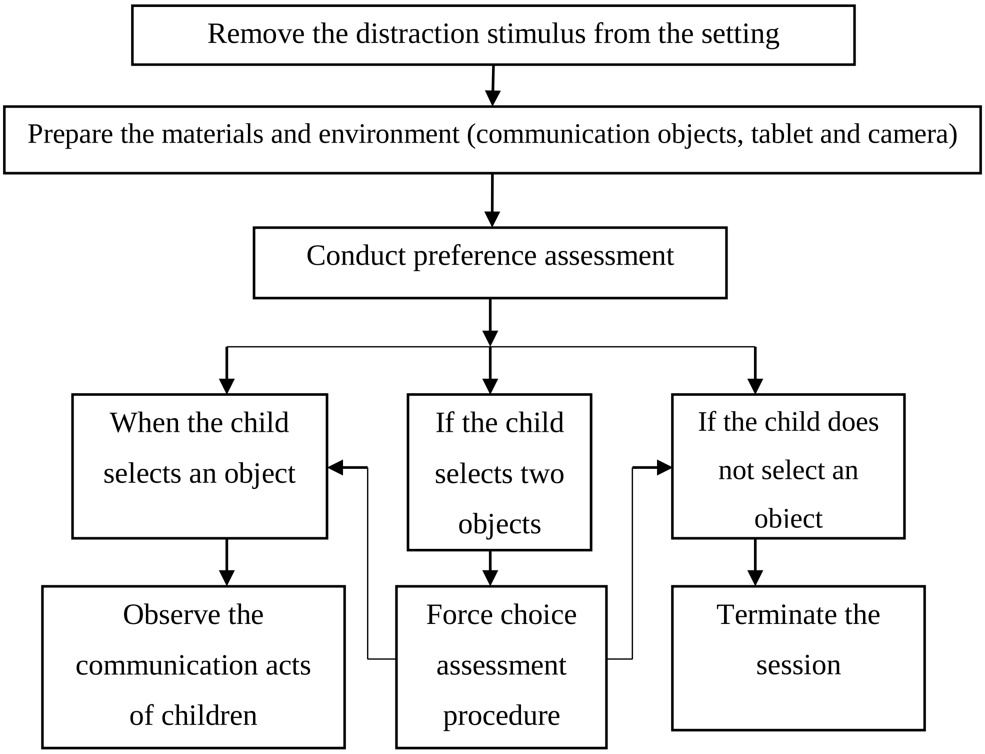


Figure 3.11. The Flowchart of Preference Assessment Procedure

3.5.3.1.6.1. Intervention Conditions

In current study, a similar procedure of PECS protocols was followed with each child in the intervention conditions. Therefore, instead of merely focusing on a treatment, several sequential treatments were employed throughout the sessions. The task analysis procedure (see Table 3.11) presented above provided insight into design of treatments. Accordingly, five subsequent treatments were implemented for the following tasks; teaching the use of EBA for requesting via physically assistance, teaching spontaneous use of EBA, teaching simultaneous simple discrimination of pictures, teaching simultaneous conditional discrimination of pictures, teaching sentences structure. These five tasks are interrelated to each other and aims to reach the ultimate goal of requesting an object independently by using EBA sentences structure. In order to teach these five tasks, initially a treatment was provided as detailed below. After the treatment, data related to the five tasks were collected.

Figure 3.12 illustrates the whole process in intervention session. Once the child selected an object at preference assessment, the treatment procedure was initialized. This process, firstly, started with teaching children the use of EBA for requesting the selected object trough physical assistance. In this treatment, the child and the communication partner sit a table face to face. When the child attempted to reach the desired object in front of the communication partner, a physical assistance was provided by a physical prompter behind the child. The physical prompter helped the child to touch the desired object's picture on the tablet. As soon as the child touch the picture on the EBA application, the tablet generated a speech of desired object and the picture of the object was illustrated on the top of tablet. Then, the desired object was given to child by the communication partner simultaneously. While giving the object the communication partner stated the expression of "you wanted this" towards the child. This implementation was repeated till to child make a connection between desired object and its picture on the tablet. After such connection occurred, the physical prompts were extracted gradually and the participants were observed for about two weeks to figure out how they requested a desired object by using the EBA within the scope of first task.

When the child learned the first task, a smooth transition is made to the second task. While the child could be able to initiate the communication by touching the desired object's picture on the tablet in front of him/her, the location of the tablet was changed at the second task. The distance between tablet and the child was increased gradually in this process. Additionally, the position of the communication partner changed in the room after the child learned getting tablet at a different location and initiating the communication. By means of that, it was intended to teach the spontaneous use of EBA. In case of the child did not accomplish the task, physical prompter provided little clues to the child. This procedure was continued till to child learn the spontaneous requesting by using the EBA.

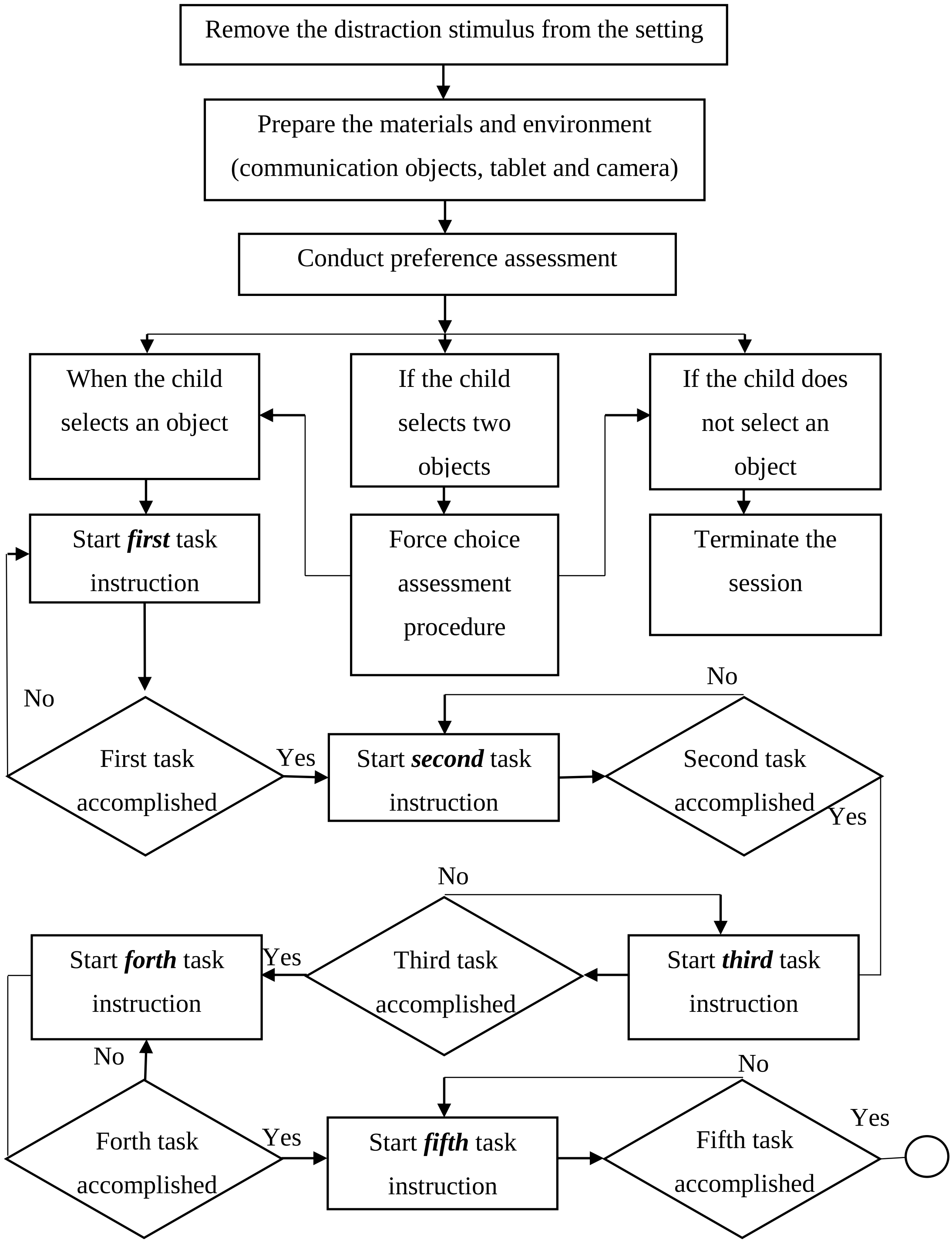


Figure 3.12. The Flowchart of Intervention Sessions

The third task included teaching children simultaneous simple discrimination of pictures on the EBA. In order to teach this task, initially two objects' pictures were captured and their names were vocalized through the EBA application. While one of these objects was a desired object by the child, the other one was neutral for the child. In this phase, it was expected children to discriminate and touch the desired object pictures from two pictures. If the child had difficulties in selecting the picture, the physical prompter gave clues to select it and four step-error correction procedure also employed. After the child discriminate the picture of desired object's picture, the location of the tablet and the position of the communication partner changed as in second task. At the end of this procedure, the child was expected to take the tablet anywhere in the room and approach the communication partner waiting a different place in the room, and to initiate the communication act by selecting desired object picture from two pictures on the EBA screen.

The forth task was similar to the third one, but it included conditional discrimination of pictures. In other words, both of the pictures on the EBA screen was desired object for children. Whichever picture the child selected, the object corresponding to selected picture was immediately given. Once the child discriminated two objects, new desired objects were added to the EBA. The same prompting procedure of previous tasks was also used in this phase. By the end of this phase, the child could be able to discriminate more than three pictures on the screen.

The final task was to initiate the communication by requesting a desired object in a sentence form. Till to this phase, children learned to use EBA from an interface where all the desired objects were listed. When the child touched the picture on this interface, he/she could be able to get the object. And as soon as the touching act was occurred, the picture of the object was seen on the top of screen and the tablet was generating the voice of merely the name of object. In sentences form, however, children should be able to discriminate the "sentence" picture on the EBA screen, then touch the desired object's picture. In addition to objects' picture, a sentence form was also provided at the top of screen, which included the pictures for "I" (in Turkish "Ben") and "want" (in Turkish "istiyorum"). Once the child discriminated the "sentence form" and touch the desired object picture, three pictures were presented on the top of screen in an order of "I want this (the object)" (in Turkish "Ben bunu (obje) istiyorum") with its vocalization. During this phase backup-error correction procedure was employed. At the end of this phase, children were expected to take the EBA application and to open the sentence form, to approach the communication partner and to express what he/she needed.

3.5.3.1.6.2. Follow-up Sessions

A follow up session was conducted after three weeks later from the last intervention session. The follow-up session was conducted to examine the maintenance of recently acquired communication skills. Participants were merely observed and did not get any physical prompt. Furthermore, error-correction procedures were not employed. The same conditions of the intervention sessions were also arranged for this session.

3.5.3.1.7. Data Collection and Analysis Procedure

Data was collected from the 26 intervention sessions and a follow-up session. Accordingly, 27 sessions were conducted to collect data throughout the process. Five implementations were done for each session.

Data collection procedure was divided into three sections (see Table 3.19): before the implementation, during the implementation and after the implementation. In order to gather detail prior information about the children with ASD, demographic information form, prerequisite skills form and reinforcement form were prepared. These forms were filled by parents and teachers in a week.

Table 3.19. *Data Collection Procedure in Evaluation Phase*

Process	Purpose	Instruments	Practitioners
Before the implementation	-	Consent form	Parents
	Prior knowledge	The demographic information form	Parents
	Prior knowledge	Prerequisite skills form	Parents, teachers
	Prior knowledge	Reinforcement form	Parents, teachers
During the implementation	Intervention session Follow-up session	Observation form	Researcher
After the implementation	Inter-observer reliability	Observation form	Observer
	Procedural fidelity for intervention	Fidelity check-list	
	Procedural fidelity for follow-up	Fidelity check-list	

During the implementation process, functional communication data were collected from intervention and follow-up sessions. Observation forms were used during this process. Researcher participated as a practitioner to the data collection procedure. The data collection process lasted about 13 weeks during this phase. In order to analyze the functional communication data, checkmarks on the observation forms were transformed to 1. In other words, if a participant performs a correct action, then this action is graded as one. The other actions were graded as zero. IMS SPSS packed program was used to calculate mean value of functional communication and requesting data.

In order to ensure inter-observer reliability and procedural fidelity for intervention and follow-up sessions, two observers from the instructional technology department participated to the study. Observation form and fidelity check-lists were used in this process.

3.5.3.1.7.1. Before the Implementation

Before the implementation, required permission was gathered from relevant institutions. Additionally, parent permission was taken from the parents of participants. In order to familiarize with the participants, we made home-visits to each family and gathered demographic information about the children and the families. To conduct the study suitably, prerequisite skills about the study was obtained from the families. By using the reinforcement form, children's interests were collected from the family. Then, the collected data was reviewed with special education teachers of each child.

3.5.3.1.7.2. During the Implementation

During the implementation of the EBA, it was aimed to find adequate answer for the second research question.

The intervention sessions were conducted two times in a week and lasted 13 weeks. Five implantations were done within each session. During this period five types of functional communication data were collected, which are (1) use of EBA for requesting after physical assistance, (2) spontaneous use of EBA, (3) simultaneous simple discrimination of pictures, (4) simultaneous conditional discrimination of pictures, and (5) use of sentence structure for requesting. These data were calculated based on each correct action of participants. To calculate functional communication data with regard to predetermined tasks, participants' action on subtasks were checked. In order to accept that a certain task is accomplished successfully, all of the subtasks need to be accomplished by the participants. For example, there are three subtasks of the second task. If participants do not complete one of these subtasks, they get zero point for the second task, even if they complete the other subtasks successfully.

Table 3.20. Summary of Intervention and Follow-up Sessions

Sessions	Data Type	The Number of Sessions	Time
Intervention sessions	Use of EBA for requesting after physical assistance	4	2 Weeks
	Spontaneous use of EBA	6	3 Weeks
	Simultaneous simple discrimination of pictures	7	3.5 Weeks
	Simultaneous conditional discrimination of pictures	3	1.5 Weeks
	Use of sentence structure for requesting	6	3 Weeks
Follow-up	Use of sentence structure for requesting	1	1 Week

After three weeks, later from the last intervention session, a follow-up session was also conducted for the use of sentence structure for requesting. Six implementations were done during the follow-up session. Table 3.20 summarizes the data collection procedure of intervention and follow-up sessions.

3.5.3.1.7.3. After the Implementation

After the implementation of the treatment, reliability data were collected in general. As mentioned previously, each implementation session was recorded with a camera. These video tapes were used to determine inter-observer reliability and procedural fidelity of the effectiveness data. In order to ensure the internal validity concerns, two instructional technologies take part in the study. Two observation forms (1: intervention and follow-up session data collection form [Appendix L], and 2: intervention session procedural fidelity from [Appendix M]) were used throughout the process. They first watched each task's last session and by using the observation forms evaluated to the children's behaviors and appropriateness of the actual practice.

CHAPTER 4

RESULTS

In this chapter, the data gathered from focus groups study, expert reviews and the implementation of the EBA in the field were presented in accordance with the research questions under investigation. The titles of the results section were organized in the order of need analysis results, design principles of EBA, and functional-communication and requesting data. The Table 4.1 illustrates the organization of the result sections.

Table 4.1. *Titles of Findings Based on Research Questions*

Research Questions	Section
What are the teachers’ opinion towards the use of mobile technologies in special education?	Special Education Teachers Opinions about the mobile technology usage
What are the design principles of EBA mobile application designed for communication needs of individuals with ASD based on the subject-matter experts’ considerations?	Design Principles of EBA
How effective is the mobile application in functional communication for individuals with ASD? • How effective is the mobile application in requesting a desired object for individuals with ASD?	Functional Communication

The first research question was examined during the analysis phase. Based on the focus group analysis results, special education teachers' opinions toward the mobile technology usage in the field were revealed. Additionally, these results were also used to refine the first prototype and to derive design principles for AAC applications. The second research question was examined from the beginning of analysis stage towards the end of the evaluation phase. Therefore, a variety of results regarding second research question was presented in this chapter. In accordance with these results, different iterations of the EBA were proposed. In this section, therefore, not only the result of previous analysis but also the improvement procedure of EBA was presented. Additionally, results regarding second question were also provided under the title of functional communication data.

4.1. Focus Group Analysis Results

While designing a solution for a certain problem, the characteristic of the target group is the key point to start. Although the diagnostic criteria for individuals with ASD are identified clearly, it is more realistic to determine the characteristics of such group based on the experience of special education teachers in the field. In this regard, the characteristics of individuals with ASD were categorized into six sub-themes based on the focus group analysis results to understand the design concerns of a potential mobile application.

Table 4.2. *Teacher Considerations about the Characteristics of Individuals with ASD*

Theme	Sub-theme	Special Education Teachers' Statements
Characteristics of individuals with ASD	Individual differences	"The severity level of ASD varies from student to student… Although there are several diagnostic criteria, every student is different in autism."

	Behavioral problems	“I think, individuals with ASD put up a wall in their environment. And the tills of this wall are obsessive behaviors, behavioral problems, and stereotyped behaviors.”
	Lack of attention	“One of the indicators of ASD is the lack of attention. Individuals with ASD become distracted easily”
	Social interaction and communication problem	“There is “speech problem” in our students. For instance, three of four students do not speak in general.” “They are so inadequate in social communication skills as well.”
	Permanent learning	“One notable characteristic of our students is that once they learn something or are accustomed to something, they do not forget it easily.”
	Lack of self-care ability	“There is also lack of self-care ability in our students, especially in toilet self-care skill.”

As indicated Table 4.2, there are six main characteristics of individuals with ASD, which were presented under the name of “individual differences”, “behavioral problems”, “lack of attention”, “social interaction and communication problem”, “permanent learning” and “lack of self-care ability”.

Social communicative impairment is one of the diagnostic criteria of ASD. This problem was also emphasized by the participants in the current study. According to focus group analysis results, the communication problem comprises both verbal and nonverbal behaviors. In terms of verbal behaviors, they have difficulties in expressing themselves. Additionally, they generally keep away from making eye contact and social interaction. Table 4.3 shows the type of the communication problems that individual with ASD faced in society.

Table 4.3. *Communication Problems that are Faced by Individuals with ASD*

Theme	Sub-theme	Special Education Teachers' Statements
Communication problem of individuals with ASD	Lack of expressive language	"The most frequently seen problem is lack of expressive language. They do not express what they want."
	Lack of eye contact	"At the first time, there is no eye-contact. They generally do not make an eye contact in their communication acts."
	Lack of social interaction	"There is no a healthy friendship in a community. They are avoiding physical contact."

There are different types of treatment in ASD. Early diagnosis is so crucial to obtain positive outcomes from the treatments. The educational programs generally cover the topics that are related to the social communicative skills and atypical behaviors. These educational programs follow: "structured teaching periods, reinforcement of spontaneous communication, instruction of specific skills using principles of reinforcement, and incidental learning." (Hyman & Levy, 2013, p.357). Table 4.4 shows the three instructional methods or techniques used in treatment programs. According to focus group results, learning activities were formed around the individualized educational program (IEP). This program includes certain information about the individual with ASD. Additionally, applied behavior analysis is commonly used behavioral treatment in ASD. Positive reinforcement, especially, frequently referred technique is employed to teach a terminal behavior or a skill. Furthermore, children with ASD tend to teach something by modeling someone else. In class activities, for example, children with ASD can accomplish a task by imitating the other children.

Table 4.4. *Instructional Methods and Techniques Used in Treatment Programs*

Theme	Sub-theme	Special Education Teachers' Statements
Instructional methods and techniques	Use of positive reinforcement	"… There was a student who had atypical behaviors. He was into cartoons. When we gave these cartoons to him, the rate of undesired behavior that walking around the class decreased. For example, when we put the cartoons on the desk, the child started to sit the desk."
	Modeling	"For example, while we were ordering the cartoons with a child, another child with ASD saw us and started to order the cartoons in a similar way. In class, students who make certain tasks become model for the ones who do not make such tasks. "
	Individualized teaching	"At the beginning of each semester, we prepare an individualized education program for each student with ASD. In other words, how can we teach based on the capabilities of the student, what are the enjoyments of the student, what s/he likes? If the child likes eating, I choose examples related to the eating."

4.1.1. Research Question 1: Teachers' Opinions about the Use of Mobile Technologies

The EBA is an aided AAC tool running on tablet computers. In this regard, it is crucial to understand individuals with ASD's attitudes toward the technology from special education teachers' point of views. According to focus group results, technologic devices might be “motivator” and “attractive” for the target group. Table 4.5 illustrates special education teachers’ concerns about the role of technology.

Table 4.5. *Role of Technology for Individuals with ASD*

Theme	Sub-theme	Special Education Teachers’ Statements
Technology for individuals with ASD	Motivator	“Last month, one of the teacher in our school brought her tablet. We downloaded some matching games for our children. We tried these games with the students with ASD as well. This time, the activity became like a game for the students rather than a lecture, and they participated the activities more entertainingly and willingly”
	Attractive	“Everything on the tablet takes their attention. There is attention deficient in our students. While doing something, they almost have lack of attention. Because they interest tablets very much, I think they might learn very rapidly by using the tablet.”

According to special education teachers, children with ASD can be able to use mobile devices in accordance with their needs without any help from the outside. Applications including videos, games and animated cartoons take their attention very much. (see Table 4.6)

Table 4.6. *Characteristics of Mobile Application Taking Interest of Individuals with ASD*

Theme	Sub-theme	Special Education Teachers’ Statements
Applications drawing	Mobile games	“We have currently a student who has neither receptive language nor high intellectual capacity. But,

their attentions		recently his mother came to school with her mobile phone. He took the mobile home from his mom, went on the internet and opened a game. Then, he played this game in a way that I could not do. ”
	Videos	“When we open a video, they watch it very carefully. But it should be something that might their attention like a motion video.”
	Animated cartoons	“Animated cartoons take their attention very much.”

As emphasized by the teachers “sounds” are drawn children’s attention. Additionally, colorful objects and shapes also take their attention. According to special education teachers, applications that address different senses of children are not only educative but also attractive for them (see Table 4.7).

Table 4.7. *Common Features of Application that Takes Interest of Individuals with ASD*

Theme	Sub-theme	Special Education Teachers’ Statements
Common features of applications taking their interests	Sounds	“Sounds take their attention very much.” “For example, when the child touches a car on the tablet, a sound of “car” or while putting the baby to sleep on the tablet, a voice of “Eee eee” could be generated.” “In addition to the visuals, auditory materials can be used. For example, we can give a “car” visual on the tablet and a sound of “this is a car” can be provided in the background.” “When they see their families, our students react differently. When they come to school, they do not want

	to move away from them. They want to communicate with their families all the time. Therefore, we can say that we can use their families' voices on the tablet, and then the outcomes of our activities might be different. For example, we make students listen to the sounds of letters on the alphabet or sounds of several animals. While doing that, if their families vocalize these sounds, the results might be positively different."
Colors	"Colorful things always take their interests."
Touching	"We generally teach something to our students by playing games. For example, look "I am driving the car" and if we give chance to the student to touch the car, it might be more beneficial."
Addressing different senses	"It is crucial to address different senses of students. The child cannot understand exactly if we teach something by showing merely its visuals. If s/he takes its voices, uses it and touches it… The more we use something addressing different senses of students, the more learning occurs."
Shapes	"Shapes can take their attention, e.g. an animal shape that s/he likes"

Focus group study gave insight into screen design of EBA. Table 4.8 shows teachers' considerations about the design issues of a mobile application that might be used in functional communication. Almost all the teachers stated the importance of visuals in ASD because most of the children with ASD are illiterate. Thus, visuals should be provided in an accurate way to help them to initiate communication act. In other words, according to teachers the number of visuals on the screen should be increased gradually. Furthermore, the screen should be as clear as possible to gather users' attention. Teachers also stated that colorful objects take children's attention. But some of the children do not enjoy certain colors, thus these colors should be customized according to characteristics of children.

Table 4.8. *Screen Design of Mobile Application Based on the Considerations of Special Education Teachers*

Theme	Sub-theme	Special Education Teachers' Statements
Mobile application design objects	Scenario	"The application can include an animated cartoon so that children take someone as a model."
	Visuals	"The communication act can be initiated on the visuals. For example, in order to get a toy, the child might touch a toy image." "Because they [children with ASD] do not know reading and writing, the application should be supported with visuals." "The most logical thing while designing such an application is to use visuals. For example, visuals of toys, dolls, milk etc. can be put on it."
Screen usage of mobile devices	Gradually increasing the number of object on the screen	"The number of objects on the screen might be increased gradually in time. For instance, in the beginning, four objects' picture can be located on the screen, after a while eight pictures can be used." "The number of pictures can be increased gradually. Because some of the children's autism severity level is high. For those, two picture, for example, can be used at first. For the next level, another procedure can be employed."

	"The number of objects on the screen can be increased, and this does not decrease their comprehension."
Open background, colorful objects	"I think that the objects should be presented with vivid colors on an open background. For example, if there need to present a car, it might be red color on a white background." "The object should be colorful and the background should be clear so that the application should meet our expectations. If our purpose is to teach the concept of "telephone", nothing should take the learner's interest, but the telephone. The learner should merely focus on the "telephone's" picture on the screen." "The thing that we want to teach should be in the spotlights, and its background should not disturb the learner"
Customizable colors	"Generally, our students like all of the colors. But they still should be customizable since there are several students with obsessive behaviors." "There should be a color option the chance the color of objects." "Some of our students do not like several colors. For example, I witness the color of yellow. Some of the children are afraid of yellow or do not want to see it. Therefore, the background of the screen should not be the colors disturbing the students."

Special education teachers' views about the use of mobile technologies as an alternative communication method in ASD were also examined. Analysis results indicated that teachers generally have a positive attitude towards such technologies.

In essence, they are almost open to any suggestions that might be used as a treatment. Furthermore, instead of using mobile phones, because they have small screen sizes, they suggested the use of tablet computers. Table 4.9 shows teachers' considerations about the use of mobile technologies in ASD.

Table 4.9. *Teacher Considerations about use of Mobile Application and Possible Mobile Device in Functional Communication*

Theme	Sub-theme	Special Education Teachers' Statements
Special education teachers' attitudes toward the mobile application for communication needs of individuals with ASD	Positive	"We recently spent approximately a day for a class activity. But if we have an application, the time to reach this activity would be about five minutes. By means of that, learning procedure can be initiated more rapidly." "I think; educational applications can be used to teach communication for individuals with ASD. Because, these children are like a closed book, there is a key to open that. Which one is this key: computer, tablet, software, or concepts? Probably, it could not be helpful for each child, but certainly, there would be ones who would benefit from it. "
	Hesitant	"In order to make the application more beneficial, learners need to be at an adequate level. That is, his/her receptive language and readiness toward to learning need to be adequate. The first step of understanding and listening is to make eye-contact. If a child does not make eye-contact, how does the application works? It could be difficult, but still, a positive result can be taken. As a result, without trying we cannot say anything."

Recommended mobile devices	Tablets	“Tablets can be used. Because, use of mobile phones might be difficult, and personal computers are problematic in terms of mobility.” “Tablets can be used. Because, not only the icons on the device are in big sizes, but also it is easy to carry. And since the size of icons is big, it addresses the visuality. For instance, because the screen size of mobile phones is small, the child might not know where to touch or what to do.” “Tablets can be used. But it depends on the child. For instance, the age of the child is small, use of tablet might be difficult in terms of mobility, and a small device can be preferred. ”

4.2. Research Question 2: The Data Related to the Design Principles of EBA

This part consists of two sections: first, the improvement of the EBA in time and second, analysis results supporting such improvement.

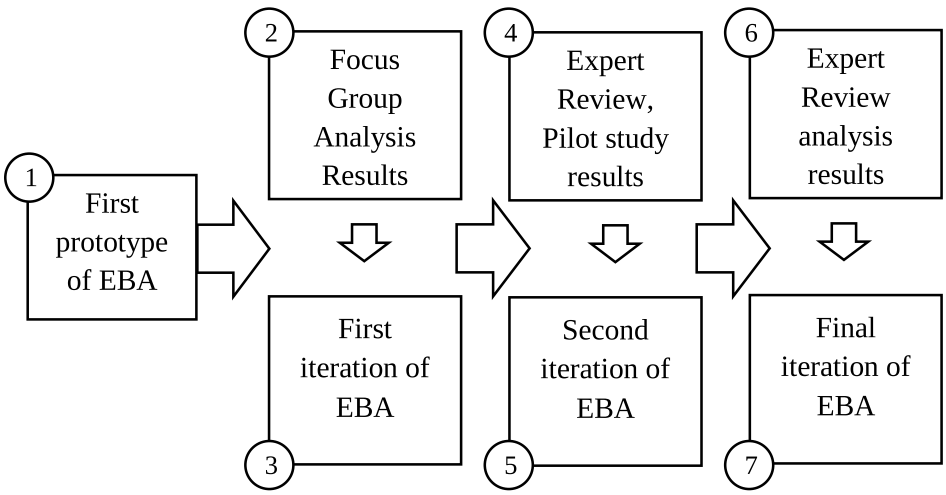


Figure 4.1. Organization of Results for the First Research Question

Initially, the first prototype of EBA was presented. Then, the focus group analysis results of the study were provided. Based on these results, several refinements were made on the EBA which were presented as the first iteration of EBA. After that, the first expert review and pilot study analysis results were provided. The second iteration of the EBA was presented by taking previous analysis results. Finally, the last expert review results were presented and the final iteration of the EBA was proposed. The Figure 4.1 illustrates the organization of results regarding first research question.

4.2.1. First Iteration of the EBA

This section consists of two parts. First, initial design principles were presented based on the focus group analysis results. Second, improvement procedure of the EBA was presented depending on the initial design principles.

4.2.1.1. Initial Design Principles

In this part, initial design principles were presented based on the focus group analysis results. Table 4.10 summarizes the design principles and related themes derived from focus group analysis results. Additionally, a check mark was inserted in front of each principle to show whether the suggested principles were offered at the first prototype or not.

Table 4.10. *Initial Design Principles of EBA*

Control	General Principles	Themes
√	The application should be specialized according to special needs of individuals with ASD.	Characteristics of individuals with ASD
√	The screen design of the application should be insulated from distracting factors.	

√	The number of visuals should be increased gradually on the screen	Screen usage of mobile devices
√	The background of the application should be simple.	
-	Colors, visuals, and sounds used in the application should be specified by the user	
√	The screen should be as bigger as possible	Recommended mobile devices
√	Sounds should be generated as natural as human speech. Instead of generating synthetic voices, the voices of people who are familiar the individuals with ASD such as parents and teachers should be used.	Common features of applications taking their interests
√	The EBA should provide acceptable features like sound generation which might be widely accepted by the society.	
√	Visuals should be presented with an appropriate color and once touched them the application should generate a speech that corresponds the selected visual	

Every individual in ASD is different from each other. Although there are certain diagnostic criteria in determining ASD, there is a variety of individual differences among the patients. These differences can be seen in their social communicative behaviors, self-care abilities, learning strategies and so on. Therefore, while designing an application for any special needs of individuals with ASD, the application should be specialized in accordance with the needs of individuals with ASD.

One of the commonly seen features of individuals with ASD is that they are more prone to lose their attention while on a task. Any external factor like a noise or internal factors like psychological state of the individual can lead this situation. Therefore, the screen design of the application should be insulated from distracting factors. One way of doing that is to design of the screen should be as clear as possible. In other words, the background of the application should be simple. According to teachers the screen sizes of mobile phones might be small for children with ASD, so that tablet computers might be preferable in practice. Therefore, bigger screen sizes are recommended for the application that could be used in functional communication. Additionally, the design of the application should motivate children intrinsically to accept the use of the application.

According to teachers, children are more sensitive to sounds, visuals, and colorful objects. These three components should be used in harmony in the application. That is, the visuals should be presented with an appropriate color and once touched them the application should generate a speech that corresponds the selected visual. The number of visuals should be increased gradually on the screen. One thing that needs to be considered is that all of these components should be customized according to individual needs. First of all, the application should give chance the user to insert and update the visuals. Secondly, sounds should be generated as natural as human speech. Because the target group acts responsively towards the people who are familiar them such as parents and teachers, their voices might be recorded to use them in the application. Finally, as stated by teachers some of the children feel uncomfortable with certain colors. In order to overcome this problem, all of the colors used on the application should be specified by the user.

As indicated previously, learning activities in ASD are prepared according to individualized educational program (IEP), which is prepared at the beginning of each semester. This program includes information regarding what the child likes or dislikes and child's current educational status. In this regard, the EBA should not conflict with the IEP. In other words, it should include a flexible basis for communication acts.

The current study aimed to provide an alternative way to enhance the communication skill of target group. As indicated previously, verbal and nonverbal communication problems are the commonly seen disabilities of ASD. In this regard, the EBA is prepared to overcome this problem. In order to enhance expressive language, the EBA should provide acceptable features that might be widely accepted by the society. However, the EBA does not provide any additional features towards to nonverbal communication skills by itself.

Most of the educational programs in ASD contain the principles of applied behavior analysis (ABA). From a behaviorist point of view, positive or negative reinforcements are used to help the learners to understand the consequences of a certain behavior. Therefore, the procedures of ABA require a progress in behavior change. In this regard, the implementation procedure of the EBA relies totally on the principles of ABA and accordingly uses the principles of reinforcement, which were detailed previous section. But, the EBA was not associated with ABA in terms of providing design principles.

Focus group analysis results revealed that children with ASD like watching videos, animated videos and playing mobile games. While doing these, they also use mobile devices without taking any help from outside. However, we did not embed such features inside the EBA because they might preclude children from initiating communication acts. In other words, as stated by teachers they might distract their attention during the implementation of EBA.

4.2.1.2. Refinements on First Prototype of the EBA, the Second Prototype

Previously, initial design principles were presented. Some of these principles are already offered in the first prototype of the EBA. It could be inferred from the Table 4.10 that the EBA should be designed in a flexible manner so that users customize its features depending on their needs. Two main refinements were made on the second prototype of the EBA.

1. A connection was added to the login page at the categories page.

2. In order to increase the users' autonomy on the application, a new setting page was prepared.

The new advance setting page was designed to meet all of the design principles previously presented. To access the setting page a new icon was located to the left-top of the category screen. In this page, three new features of the EBA can be controlled as explained and illustrated in Figure 4.7 below.

- A new feature was added to change the template of the EBA. By means of that, all the colors in the EBA can be customized by the user.

- Previously, only the voice records of the object could be updated. However, the subject and the verb records in the sentence form were made only once. In the second prototype of the EBA, a new feature was added to update all the voice records.

- A log tracking system was added to the second prototype of the EBA. This system saves all the activities done by the user. The user can make search, filter or order on the logs. A pattern about the users can be inferred from the logs in terms of what kind of objects they requested, how long they have been using a certain object for requesting and so on.

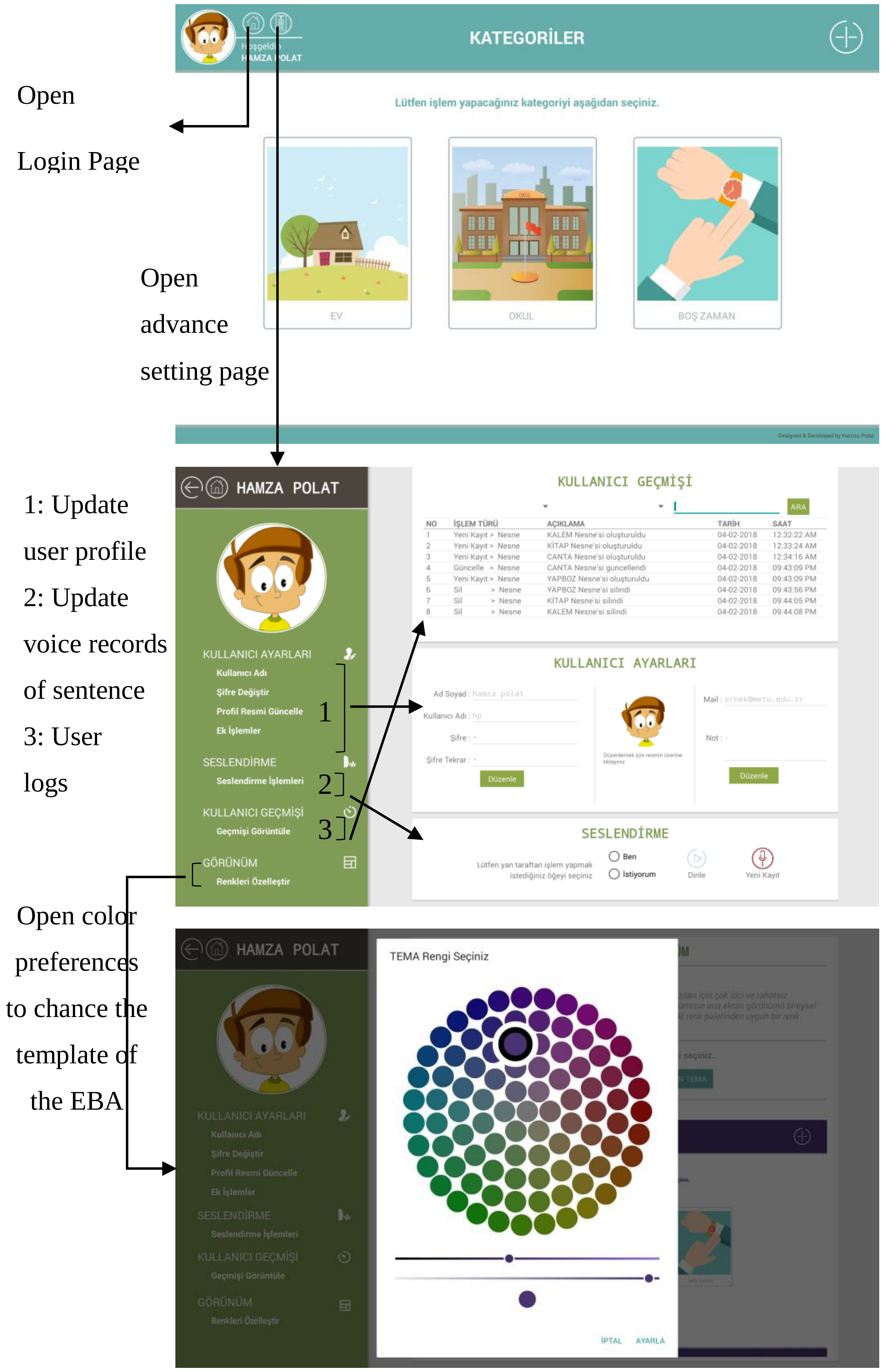


Figure 4.2. Refinements on the First Prototype, the Second Prototype of the EBA

4.2.2. Expert Review I and Pilot Study Results

The second prototype of the EBA was provided based on the initial design principles at the previous section. In this part, expert review analysis results of the second prototype and the pilot study results were presented.

4.2.2.1. Expert Review I Results

The first expert review analysis results were categorized into twelve topics which covered (1) appropriateness of the EBA for the target purpose, (2) appropriateness of the EBA for the target group, (3) whether the EBA meets the expectations of practitioners or not (4) new features that could be added to EBA, (5) evaluation of the user interface of the EBA, (6) use of colors in terms of target group and purpose, (7) whether the texts used in the EBA informative or not, (8) the navigation system of the EBA, (9) possible reasons to use the EBA, (10) favorable aspect of the EBA, (11) unfavorable aspect of the EBA, and (12) any existing features suggested to change. Additionally, analysis results also include several suggestions for the implementation process of the EBA.

According to special education teacher, in order to obtain effective results from the implementation of EBA, firstly it is important to take children's attention. One way of doing that is to collect as much information about the children as possible by interviewing with teachers and parents. These interviews should focus the characteristics of each child in terms of what they like or dislike to use them as reinforcement during the implementation. One more thing that was stressed by the expert was that in order to implement the EBA effectively, there are several prerequisite skills that children need to acquire. For example, as teacher stated, "*To be able to use the EBA, children need to have certain skills such as matching, distinguishing, and categorizing.*" Although it is not a prerequisite, the teacher emphasized the critical role of receptive language during the implementation of EBA. As stated by the expert "*Children's receptive language should be developed prior to* *starting the implementation. I mean, when we asked to look, s/he should look; when we asked to show, s/he should show; when we asked the touch, s/he should touch."*

First of all, appropriateness of the EBA for the target purpose was evaluated by the expert. According to him, if the implementation of EBA meets the prerequisite skills, it could be used to enhance functional communication. Before the implementation of the EBA, the expert suggested collecting information about the children. If the collected information matches up with the capabilities of the EBA, then it could be appropriate to the target purpose. The teacher stated that "*Social-cultural status of the child should be investigated first, and then the needs of the child should be identified, a meeting should be held with the child's family and teachers to identify the sounds, objects, foods and beverages, symbols, and colors, which are in child's environment*." As a result, it might be concluded that the EBA can be used as an assistive technology in the communication of individuals with ASD under the condition that children have prerequisite skills presented before and if the EBA can be customized based on the children's needs.

The second evaluation criterion was the appropriateness of the EBA for the target group. In this regard, the expert again stressed the importance of prerequisite skills. According to him, if we meet these prerequisite skills before the implementation, the EBA might be suitable for individuals with ASD. He expressed this issue like this "*There are a variety of children with different disabilities. For example, if ASD accompanies the attention-deficient disorder or if the child does not use his/her hands, then the EBA does not appropriate for these children.*" Therefore, any physical handicap might restrain the use of EBA by the target group.

Thirdly, the content of the EBA was evaluated by the expert whether it was suitable for the target group and purpose. The teacher again stressed the importance of characteristics of each individual with ASD. According to him, "*If the symbols, objects, materials, and sounds used in the application were selected by considering* *the needs of children and from the environment where the child was already in, then it might be appropriate.*"

The EBA was reviewed in terms of additional features that might be provided at the third prototype. The expert expressed his concern about the obsessive behaviors commonly seen in ASD. According to him, children with ASD need to be restrain while using the EBA. He stated that "*Especially children with ASD should not be exposed to screen-based media. I mean, if they spent too much time with them, children may be obsessed with such media. ...When you try to remove the media, this time certain undesired behaviors are occurred such as resisted behaviors, deliberate self-harm, crying, and getting angry. This might continue till to get the desired object."*

The main philosophy behind the use of EBA is to enhance functional communication of individuals with ASD, which requires a treatment procedure. At the beginning of the treatment, the application should be taught to the target group. To teach the EBA, firstly the practitioners need to be familiar with EBA. Due to these concerns, the expert reminded the necessity of having user manuals of EBA for the implementers. He touched on this issue by saying that "*Certainly there needs to be someone or something that can introduce the application before the implementation. For example, if you did not demonstrate it to me, I would not understand what you aimed at these. I mean there needs a help documentation to show the practitioners what the ultimate goal is and what kind of behaviors we are expecting from the children while they are using it.*"

The other issue was the evaluation of colors in terms of the target group and the purpose. As mentioned previous section, the expert also emphasized the importance of colorful design and use of transverse colors, which help children to more focus on a certain task during the implementation. According to expert, the reason why vibrant colors are preferred by the children is that "*There are several students who were diagnosed with ASD. But sometimes, different disabilities like visual impairments may accompany the ASD.*"

The EBA was also evaluated in terms of informative texts and navigation system. The expert gave several suggestions to make the use of the application easier. His first concern was about the font sizes on the screen. According to him, the texts should be provided in bigger sizes to increase their readability by the practitioners. While doing that the contrasts among the text colors should be increased. Additionally, the informative texts should be more informative and directive. He also requested to add informative texts to the navigation system. However, since most of the children with ASD do not have literacy skills, he did not make any comment about the use of texts in terms of children.

The expert also explained one of the main reasons for using the EBA. According to him, the EBA can save time if it is used properly. Additionally, this kind of applications attracts the practitioners very much because it's the technological age and children are interested in such devices. The EBA was appreciated by the expert due to several features it has. These are the visual representation of desired objects on a board, speech generating feature of the application, and portability and affordability of the application.

4.2.2.2. Pilot Study Results

The pilot study was conducted before the main study to examine the actual use of EBA in practice. During the implementation, two children with ASD were observed on how they made a request for the desired object. In this section, requesting data gathered from baseline and treatment sessions were presented.

The requesting data for two participants were shown in Figure 4.8. The vertical axis of the graphs represents the percentage of correct actions during the sessions. In other words, the percentage of behaviors that were performed to get the desired object through EBA. On the other hand, the horizontal axis shows the both baseline and intervention sessions. Three baseline and intervention sessions were conducted in the pilot study.

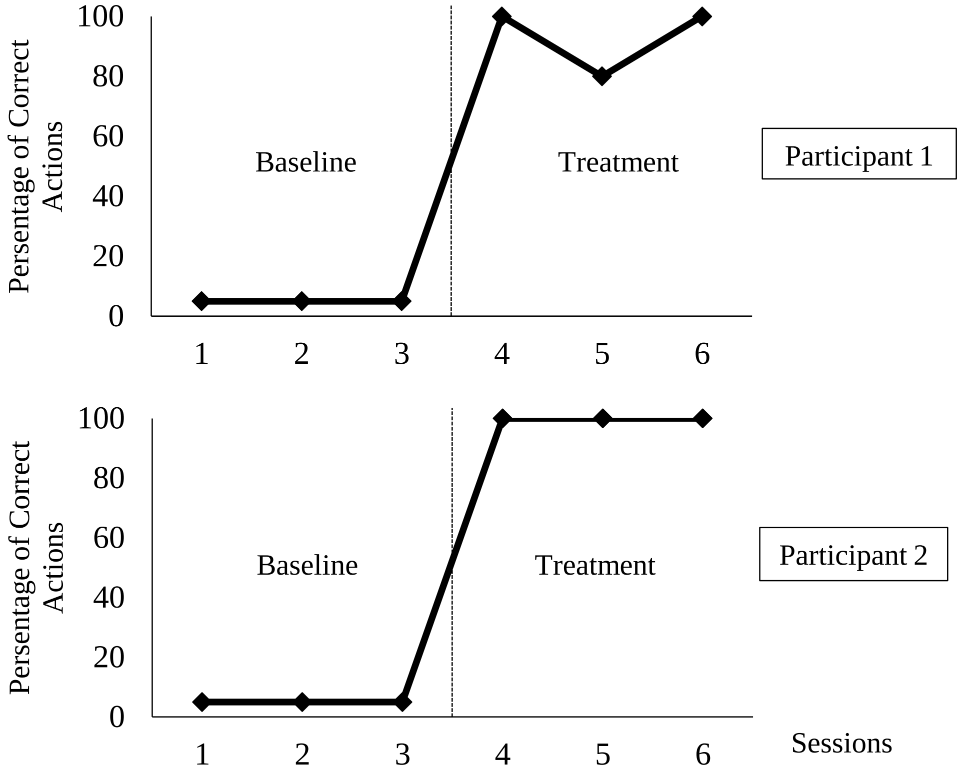


Figure 4.3. Requesting Data for First and Second Participants in Pilot Study

The correct response of the first participant was 0% in the baseline condition. It means that he did not perform the correct communication act (requesting) by using EBA to get the desired object before the treatment. However, after the treatment with EBA, he performed 93% correct responses.

Three baseline conditions were also performed with the second participant before the intervention session. During the baseline session, the second participant did not perform the correct action for requesting. However, after the treatment, there is a big increase in the correct response rate. She used the EBA to get the desired object in all cases and performed 100% correct responses.

4.2.3. Second Iteration of The EBA

This part consists of two topics. First one is the refinements of the previously determined design principles, which were derived from the first expert review and pilot study analysis results. The other one is the refinements on the EBA's existing features. New features were added to the EBA based on the new design principles.

4.2.3.1. Refinements of the Design Principles

As indicated in the expert review analysis results, the expert emphasized the prerequisite skills that need to exist in the target group. These skills can be classified into cognitive and physical requirements. Cognitive prerequisite skills are the abilities to match, distinguish, and categorize objects presented on the EBA. On the other hand, physical prerequisite skills are the physical readiness of the child for the use of EBA. According to expert without ensuring these skills, children with ASD do not likely utilize from the EBA in functional communication. In this regard, it was not feasible to make refinement on the existing design principles because these skills have the characteristics that cannot be handled properly by a mobile application.

After meeting these prerequisite skills, the expert recommended selecting of the objects from the child's socio-cultural environment. Then, these objects should be determined in the EBA to help children to initiate communication by using the objects from the zone of proximal development of the child. The case that the selection of the communication objects in accordance with the child's needs refers to the importance of customizable applications for the target purpose. Because, a design principle that "*the application should be specialized according to special needs of individuals with ASD*" was already presented previously to address that issue, new design principles regarding individual differences were not provided in this section.

In order to improve the quality of the EBA and to be able to use it in accordance with the research purpose, the expert touched upon two critical issues. First was the obsessive behaviors towards the technological devices which are commonly seen in the children with ASD. He suggested finding creative solutions to struggle with this problem. The second was related to the practitioners who would teach the EBA to the children with ASD. According to him, they should be familiar with the capabilities of the EBA in advance because they will guide the children during the implementation. Based on the expert's concerns two more design principles were proposed as follows:

1. The application should be designed in a way that prevents children from obsessive behaviors.

2. The application should include help documentation to guide practitioners for accurate implementation.

Children were also observed during the pilot study whether there needs any improvement on the design of the EBA. As indicated Figure 4.8 they could be able to use the EBA for requesting for a deserved object after the treatment session. Therefore, any refinement was not made on the EBA. However, it was observed that communication partners followed the implementation procedure in a wrong way. They gave verbal prompts to the children during the treatment sessions. Because the treatment procedure did not contain any verbal prompts, a decision was taken to inform the practitioners to adhere to the treatment procedure during the main study.

4.2.3.2. Refinements of the Second Prototype of the EBA, the Third Prototype

The third prototype of the EBA was released based on design principles derived from first expert review results. Accordingly, two main improvements were made under the following titles:

1. A parent control service was added to the EBA.

2. Help document was embedded in the EBA

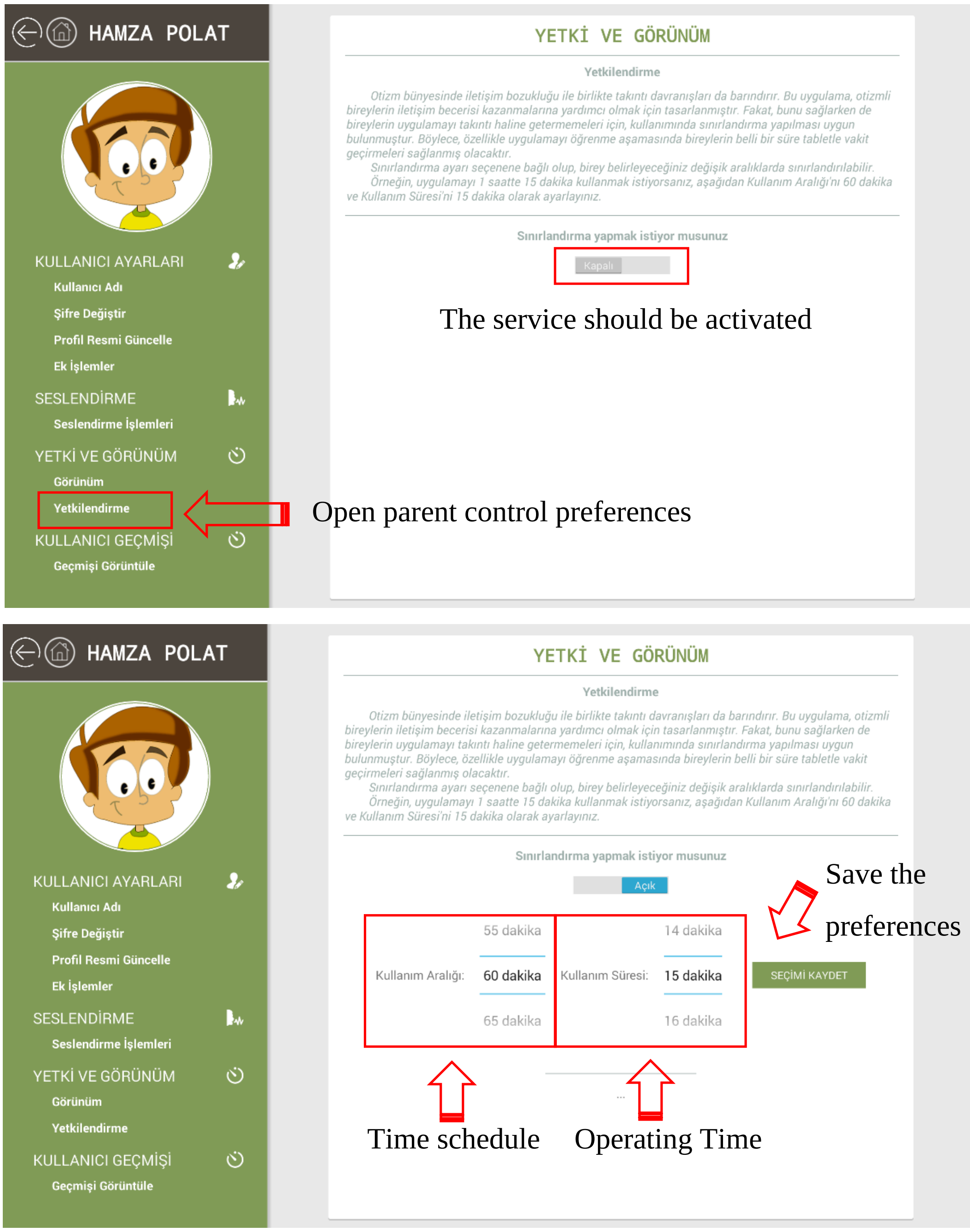
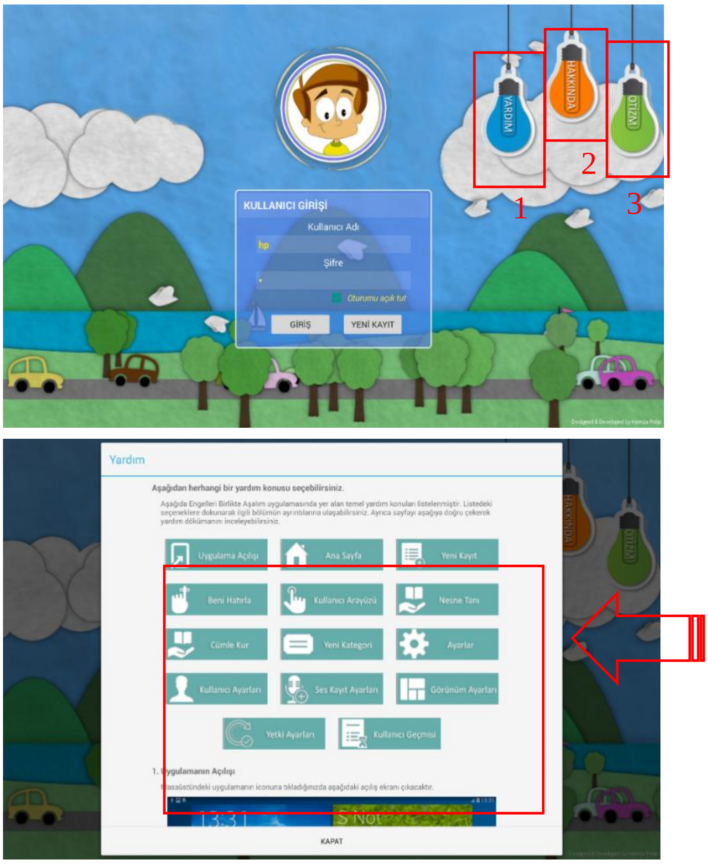


Figure 4.4. Refinements on the Second Prototype, Parent Control Service

First of all, as indicated previously the expert concerned about the obsessive behaviors. In order to prevent children from this problem, a parent control service was added to the EBA. This service helps practitioners to control the tablet for a while. In order to access this feature, a new button was added to the advanced setting page. However, it is provided as disabled by default. In order to utilize this service, it should be enabled by the practitioners. Once the service is activated the user is restricted to access the EBA temporally. Basically, the service has two main features. First, the "operating time" that identifies a time interval or session duration in which the user can utilize from the EBA. The second one is the "time schedule". The "time schedule" includes the time interval in which the user can access the EBA. It controls the "operating time". Once the "time schedule" is up, it reset the "operating time" to lunch a new session. For example, practitioners may desire that children utilize from the EBA for about fifteen minutes in an hour. In this case, "operating time" should be fifteen minutes, and the "time schedule" should be sixty minutes. Figure 4.9 illustrates how to access and use the parent control service in EBA.



Help Documents

1. Help
2. Implementation procedure
3. ASD

Help:

Introductory notes about the EBA

Figure 4.5. Refinements on the Second Prototype, Help Documents

Secondly, in order to guide the practitioners during the implementation of the EBA a help document was embedded to the system. As illustrated Figure 4.10, these features can be reached on the login page of the application. The help document includes introductory notes about the EBA, other useful resources about the implementation procedure of EBA, and brief information about the ASD.

In order to get efficient results from the implementation of the EBA, these three document should be checked by the practitioners. First, "Help" menu can be used to familiarize with the EBA environment. It includes user manuals of the EBA. Second, "implementation n procedure" menu includes several treatment tips and strategies on how to use EBA for functional communication. Finally, "ASD" menu is used to get more information about the ASD.

4.2.4. Expert Review II Results

This section includes the second analysis results of the expert review. Analysis results were presented in three ways: first, the evaluation of the EBA on a scale in terms of the desired purpose, second, teachers' views about how to improve the EBA depending on the desired purpose, and finally positive and negative aspects of the EBA.

Table 4.11. *Experts' Satisfaction about the EBA*

Items	Mean	Mode	Overall Mean
The EBA is designed for the desired purpose.	4.25	4	
The EBA is appropriate for the target groups' level.	4.38	5	4.36
The content of the EBA satisfied me in terms of target purpose.	4.25	4	

The interface of the EBA satisfied me in terms of target purpose.	4.25	4
The colors were appropriate in terms of target group and purpose.	4.63	5
The informative texts of the EBA satisfied me in terms of target purpose.	4.13	4
The navigation bar of the EBA satisfied me in terms of target purpose.	4.63	5

Table 4.11 illustrates experts' satisfaction level about the EBA in seven aspects: appropriateness of EBA for the desired purpose and target group, appropriateness of content, user interface, colors, informative texts, and navigation system. As it can be inferred from the table, the satisfaction level of all items was higher than 4. The lowest mean score was the satisfaction level of informative texts used on the EBA (M = 4.13). On the other hand, the highest mean score was the satisfaction level of both colors and navigation bar (M = 4.63). The overall satisfaction level of the EBA was 4.36.

Experts also provided several suggestions to make EBA more effective, efficient and satisfying. These suggestions were presented under the seven titles as shown in the Table 4.12. It could be beneficial to note that most of the suggestions on the table were gathered from the experts whose satisfaction level was lower, respectively.

Table 4.12. *Experts Suggestions to Make EBA more Usable*

Items	Suggestions
The EBA is designed for the desired purpose.	"It's good to see a customizable application. However, there needs an advance help or an introductory video that is presented at the beginning of the application so that parents can be able to use the EBA, easily."

	"While selecting the pictures, there should be guidance." "Instead of merely focusing on the "requesting", there should be more sentences structures." "To make the application more functional, there should be default pictures. I don't think that individuals with communication impairments can create their categories."
The EBA is appropriate for the target groups' level.	"Adding and vocalizing a new object might be difficult or impossible by the children with ASD. However, when these objects are added, they can use the EBA easily." "I think instead of just focusing on children with ASD at lower ages, you can pay attention to a certain sufficiency. E.g. children who cannot speak." "Some of the children in target group can make a sentence with four or five words. Therefore, different user stages can be identified at the application for different children. And more complex sentence structures can be added to the system for the ones who start to speak." "I think instead of giving a specific age, you can focus on a performance level. Because this makes difficult to determine the appropriateness of the application for the individuals who have different severity level. Previous studies have shown that PECS is a performance-based treatment and might generate effective results when

	studied with individuals who had communication impairments at higher ages." "It seems that someone who has communication impairment cannot use the application by himself/herself. Thus, someone else should prepare the content of the application and teach how to use it. Furthermore, the application should come with more by default objects."
The content of the EBA satisfied me in terms of target purpose.	"It could be difficult to find objects' pictures. Therefore, an object pool should be provided in the application." "Pictures addressing the "actions" might be provided. For example, "I want to run." Furthermore, the application is including a requesting sentence form. The type of the verb and subject can be varied. This can make difficult the usability of the application. But I still believe that this diversification can be made by considering the ease of use. Maybe the application can include different levels. "
The interface of the EBA satisfied me in terms of target purpose.	""Learning objects" and "Building sentence structure features" features are appearing on the same icon. The child cannot distinguish these features. Thus, they might be located at different locations."
The colors were appropriate in terms of target group and purpose.	"Customizability of the colors on the application is a good idea due to the individual differences of children with ASD."

The informative texts of the EBA satisfied me in terms of target purpose.	"The informative texts on the application, especially on the categories screen, are faded. These texts might become apparent." "Instead of naming categories, you can use "What would you like?" or "Select a place". Furthermore, while selecting a page, a vocal notification might be provided as a target language prompt for the children with illiterate."
The navigation bar of the EBA satisfied me in terms of target purpose.	-

The EBA was evaluated for both positive and negative aspects. Experts' views were categorized into six topics and presented in the Table 4.13 separately. The numbers on the expert column of the table represent the order of the experts in the study. Because some of the experts did not elaborate the EBA on some of the specific topics, they were removed from the expert column of the table.

Table 4.13. *Experts' Elaboration of the EBA on the Positive and Negative Aspects*

Topics	Expert	Opinions
The main reason/reasons that make you decide to use EBA.	1	"I think tablets are more functional than PECS books. They are more reachable and give chance to complete communication acts more rapidly."
	2	"This kind of applications would provide an alternative way for communication."

	3	“Children with ASD prone to using tablets or iPad.”
	5	“There are several reasons to use this kind of application for the target purpose. First, technological devices became widespread. Second, these devices started using in educational settings. Third, children pay much attention to these devices. Forth, it gives chance to repeat the same action several times. Finally, it allows seeing users logs.”
	6	“The fact that children with ASD learn better with technology-based applications make me decide to use them. Additionally, other reasons are that they are easy to use and they could be customizable according to individual differences. ”
	7	“I prefer because tablets became widespread.”
	8	“Because it is free, I use this application.”
Most favorable features of the EBA	1	“I think the most favorable features of the EBA is that it gives chance to practitioners to limit the time for use.”
	2	“It seems that the EBA solved the problem of finding material of the PECS. Another good aspect is the vocalization of the objects on the

		EBA. Finally, it allows individualization of the application.”
	3	“It provides a flexible basis for use. Additionally, the design of the application is simple and good. Finally, it focuses on enhancing communication skill.”
	4	“It is wonderful to see that user can specify the application and add new objects. There are several applications claim that they are instructive for students with special needs, but the user does not make any change on the application. When I analyze these applications, sometimes I say that “I wish they could do this in a different way.” From this point of view, the EBA gives authority to practitioners to make changes on its certain features.”
	5	“I think there are three positive aspects of the EBA. First, it provides an alternative communication way for individuals with ASD. Second, it gives chance to make an update on its certain features. Third, instructions for use are clear.”
	7	“I think the most favorable features of the EBA is the vocalization of the objects.”
	8	“The EBA allows to add new objects and vocalize them easily. Further, it saves the users

		actions to a database. I think all of these are the positive aspect of the EBA.”
Additional features that should be on the EBA	2	“A new section should be added to EBA for expressing social communication skill such as “Thank you”, “Excuse me”.”
	3	“A default picture pool for objects should be added to the EBA.”
	5	“Information about individuals with ASD should be provided in the informative texts. For example, an information should be provided that “Objects and sentences need to be selected based on the individual differences.” Because each child is special in ASD.”
	8	“New vocalizations should be added for the physical or emotional actions such as “I have a stomachache” or “I am angry.””
Unfavorable features of the EBA	1	“Firstly, it seems there is a gap between the pronunciation of “I” and “want” sentence components. This gap might be reduced. Secondly, the pictures corresponding to the sentence components should be enlarged and provided in the middle of the screen.”
	4	“There is no by default pictures for objects and actions. And there are no more sentence options on the sentence structure page.”

	5	"Alternative ways should be provided at the sentence structure sections. For instance, while requesting a pen, it is not natural to say "I". I mean, we prefer to use "Kalem istiyorum" rather than "Ben kalem istiyorum" in daily life."
	8	"I did not like blank categories and the title of categories screen."
Adjustable features of the EBA	1	"Pictures on the "Learning objects" and "Sentence structure" should be provided in bigger sizes and at the middle of the screen."
	5	"At the beginning of the splash screen of the application brief information about ASD and PECS implementation should be provided."
	8	"In addition to "requesting", certain new expressions should be provided."
Comments	6	"In order to make the application more usable and understandable, voice records should be more natural. To do so, the time interval between words should be reduced."
	8	"I think, there is no need to create a password on the login page, it is enough to log in the system once."

According to the first expert, there are several positive aspects of the EBA. First, it is more functional than PECS cards and gives chance to initiate communication more rapidly. Second, users might be restricted during the implementation by setting a time interval for use. However, she concerned about the picture sizes on the "Learning objects" and "Building sentence structure" screens and suggested to enlarge them. She also recommended reducing the time gap between the sentence components while the tablet generating voice record of them.

The second expert believed that the EBA has a potential to give an alternative way for communication. According to her, the strengths of the EBA are that it might solve the problem of finding appropriate material for PECS. Further, objects can be vocalized on the EBA. And finally, it can be customized depending on the needs of the users. She also suggested adding new features so that children learn the social communicative skills such as "Thank you" and "Excuse me."

According to the third expert, the good aspect of the EBA is that it focuses on a specific skill of a specific target group. And its design is simple to use. This application can be used for educational purposes because tablets are well-accepted by children with ASD. Additionally, an image pool on the application was suggested by the expert for communication objects.

According to the fourth expert, there are several applications claiming that they are helpful for special needs of the individuals with ASD. However, most of these applications cannot be specialized by the user. In this regard, the EBA is favorable because it gives chance practitioners to customize the application according to users' needs. There are two weaknesses of the EBA. First, it does not include a feature that offers by default pictures for communication objects. Second, there are limited sentence types on the application.

According to the fifth expert, mobile devices have become widespread and stated to use in educational settings. And children with ASD are interested in such devices very much. From this point of view, the EBA can be considered as a part of this trend. Apart from that, it provides an alternative way for communication. While doing that, its features can be specialized by the users. And finally, it was designed in a way that can be used by the users easily. In addition to the strength of the application, he also suggested making refinements on the informative texts to make the application better. The weaknesses of the EBA, on the other hand, is that while requesting something the subject of the sentence does not pronounce in Turkish daily language. However, each requesting attempt starts with the subjects of the sentence on the EBA. According to him, the requesting sentence structure should be as similar as in daily life.

According to the sixth expert, the EBA should be used in functional communication because he believed that children with ASD learn better with technology supported instruction. Specifically, the EBA can be preferred because it can be specified according to individual differences. He also suggested making refinements on the sounds in sentence structure. To make the sounds more natural, he also recommended decreasing the time interval between sentence-components while the device generating speech.

According to the seventh expert, tablets have become widespread. Thus, applications running on mobile devices like EBA can be used for educational purposes. Additionally, the more strength of the EBA is that it generates sounds of the communication objects.

According to the eighth expert, the strength of the EBA is that it is easier to add and vocalize new communication objects. While doing that it also saves the users' actions in a log file. But to make it better, new sentence structures for physical or emotional actions should be added. And several refinements should be made on the titles of the pages such as instead of using "categories", "what would you like?" should be used on the categories page. He also emphasized the redundant of requesting the password at the log in page. According to him, once the user signs in the system, there is no need to request the password.

4.2.5. Final Iteration of the EBA

In this section, several refinements on the design principles and mobile application were presented. First, design principles were provided based on the second expert review analysis results. Second, improvement of the EBA was illustrated depending on design principles and expert review analysis results.

4.2.5.1. Refinements of the Design Principles

In this part, two new design principles were presented based on the second expert review analysis results.

1. Object icons on the screen should be resized and repositioned by the users.

2. Sounds should be generated as natural as possible.

The first principle was related to the use of the screen. The picture size of objects on the third prototype of the EBA was fixed. In other words, users were restricted to make any adjustments on the picture sizes and positions. In this regard, the first expert demanded to change the size and position of the pictures. Changing the size and the position of the icons on the screen is also compatible with the design principles that address the individual differences.

The second principle was related to the design of sounds that were generated by the EBA. This issue was stated by first, fifth and sixth experts. To make the sounds more natural two suggestions were made. One was about the time interval between two words while the device generating speech. Experts suggested reducing this time interval. The other one was related to the sentence structure in Turkish. Sixth expert, especially, concerned about the use of subject in Turkish. Because subjects addressing the first-person singular pronoun ("I") generally are not expressed in daily life, he suggested releasing the EBA with an option that does not possess the subject in sentence form. As a result of that, the tablet would be able to generate merely the sounds of verb and objects in the sentence.

4.2.5.2. Refinements of the Third Prototype of the EBA, the Ultimate Prototype

This section includes new features attached to the EBA based on the second expert review results and updated design principles.

Firstly, the following two new features were added to the EBA by taking updated design principles into account:

1. Object sizes and positions on the can be changed according to individual differences.
2. Refinements on the sounds were made to make them more natural.
    a. The time interval between sentence component was reduced while the device generating voice.
    b. An option was added to omit the subject of the sentence in sentence form.

As it can be inferred from the previous section, there are several recommendations to make better the EBA. Three refinements were made on the EBA based on these suggestions. Firstly, experts emphasized that children with ASD may not learn how to use EBA by themselves, thus the application should be introduced to the parents in advance. To do so, additional introductory video can be embedded to the system. And according to several experts, there need refinements on the existing informative texts.

One commonly recommended suggesting was that the application should involve by default object pictures. Some of the experts insist that sometimes it could be difficult to reach real object pictures, therefore several predetermined pictures can be provided on the system. Furthermore, one expert also suggested that the type of the pictures can be varied. That is, pictures addressing the actions can be embedded to the EBA.

1. Refinements on informative texts and help documents.

a. An introductory video was added to the help documents

b. Informative texts including headings were updated in a form that are more directive.

2. An image pool addressing to the objects and actions were added.

   a. A new option was provided while selecting object pictures.

   b. Pictures were categorized into objects and actions separately.

   c. A quick search function was added to image pool screen.

3. Login page was made more functional.

   a. A new feature was added to the advanced setting panel. By means of that users did not need to see the login page till to sign out.

Finally, some of the experts also recommended adding new sentence structures to take the EBA a step further. According to them, the EBA should be customizable according to different severity levels of the target group. Once the users make progress on the existing level, complex sentence structures can be activated for him/her gradually. By means of that, the types of the subjects and objects can be varied on the sentence form. However, new sentence structures were not added to the EBA because it was designed to enhance functional communication by merely requesting.

4.2.6. Summary of Iterations

In present study, three iteration addressing to the design principles of AAC applications were presented. The first iteration was emerged after the focus group study. The second iteration was made according to first expert review. The third iteration was provided after the second expert review. Meanwhile, several refinements were made on the EBA depending on the proposed design principles. Table 4.14 summarizes all of the iterations about design principles throughout the process.

Table 4.14. *Summary of Iterations about Design Principles*

Research Method	Iterations of Design Principles
Focus Group Study	• The application should be specialized according to special needs of individuals with ASD • The screen design of the application should be insulated from distracting factors. • The number of visuals should be increased gradually on the screen • The background of the application should be simple. • Colors, visuals, and sounds used in the application should be specified by the user • The screen should be as bigger as possible • Sounds should be generated as natural as human speech. Instead of generating synthetic voices, the voices of people who are familiar the individuals with ASD such as parents and teachers should be used. • The EBA should provide acceptable features like sound generation which might be widely accepted by the society. • Visuals should be presented with an appropriate color and once touched them the application should generate a speech that corresponds the selected visual
Expert Review I	• The application should be designed in a way that prevents children from obsessive behaviors. • The application should include help documentation to guide practitioners for accurate implementation.
Expert Review II	• Object icons on the screen should be resized and repositioned by the users • Sounds should be generated as natural as possible.

In addition to the design principles, practical solutions toward to EBA was proposed in present study. Table 4.15 illustrates to the features of the EBA emerged during the study.

Table 4.15. *Summary of Iterations about Features of the EBA*

Research Method	Iterations of EBA Features
After the Literature Review	• A platform can be used to enhance functional communication • Runs on Android 10.1-inch tablets • Requires user account • Recognizes user information • Three by default categories, the number of communication categories can be increased • Use camera features of the device to capture the communication objects' pictures. The communication pictures can be updated or deleted. • Includes informative texts to operate the application • Supports both simple and multi-step requesting • Produces both visual and auditory outputs. • Use microphone feature of the device to record the name of communication objects

After the Focus Group Study	• Functional navigation
	• Setting pages
	    o Change the theme of the application
	    o Ability to update voice records
	    o Tract user actions in a log file

After the Expert Review I	• Parent control service • Help documents and user manuals on the login page

After the Expert Review II	• Refinements on informative texts and help documents
	  ○ Introductory video added to the help documents
	  ○ Heading were updated
	• An image item pool
	  ○ Option to select by default communication pictures
	  ○ Categories including objects and actions
	  ○ Quick search function to find appropriate by default picture
	• More functional login page that does not require singing in till to signing out	

4.2.7. Overall Summary of Results Regarding Design Principles of the EBA

In this section, all of the design principles were summarized, which were derived from the beginning of focus group analysis results toward the last expert review analysis results. Furthermore, the implementation of such principles on the EBA was illustrated on a table. Finally, by taking researcher's observations in the main study, the design principles were put into final form. Table 4.16 summarizes the overall design principles and their implementations on the EBA.

Table 4.16. *Overall Design Principles and Their Implementations on the EBA*

No	Design Principles	Application of the Principle on the EBA
1	The application should be specialized according to special needs of the individuals with ASD • Colors, visuals and sounds used in the	✓ A user account is required to use the EBA. By means of that, all the features might be customized depending on the needs of individuals with ASD. ✓ The EBA saves user actions on a log file separately so that practitioners can

	application should be specified. • Communication object icons should be resized and repositioned.	derive a pattern about the individuals with ASD. ✓ Color preferences feature was added to advance setting panel of the EBA so that users specialize the template of the application. ✓ The EBA allows users to benefit camera capabilities of the device so that pictures corresponding communication objects can be captured. Additionally, devices' storage can be used to select communication pictures. ✓ EBA does not support static voice records instead, sounds can be specialized depending on the characteristics of the individuals with ASD. Sounds can be updated at advanced settings panel. ✓ Pictures of communication objects on the screen can be resized and repositioned at the advanced settings panel of the EBA.
2	The screen design of the application should be insulated from distracting factors.	✓ The backgrounds where the users interact are quite simple on EBA. ✓ The EBA runs in full-screen mode of the device by default so that users can benefit the device screen completely.

	• The background of the application should be simple. • The screen should be as bigger as possible	✓ Apart from both the communication objects and the navigation bar, there is no additional media located on the screen.
3	Visuals should be used in an appropriate way. • The number of visuals on the screen should be increased gradually. • Visuals should be presented with an appropriate color. • Once the visuals are touched the visuals, the system should provide immediate feedback by generating a speech corresponding to the selected visual.	✓ The EBA was designed in a way that users can add unlimited communication objects. However, by default, it does not involve any object at the first usage. These objects should be activated by the practitioners. Once they are added, they appear on the screen one by one. ✓ Background of the communication pictures can be specialized at the advanced settings page of the application. ✓ Once the user touched communication objects, the picture of the object is illustrated at the top of the screen. Meanwhile, sounds that correspond the communication object is generated.
4	The application should generate natural sounds. • Instead of synthetic voices, natural	✓ The EBA supports voice recording. By means of it, communication objects can be vocalized by families and teachers of individuals with ASD.

	digitized voices should be used. • Sounds should be generated as natural as human speech.	✓ To make the sounds more natural, the time interval between sentence components is reduced. ✓ To get a common usage in the Turkish language, an option was added to the advanced settings page to omit the subject ("I") in sentence pronunciation.
5	The application should take precaution to prevent children with ASD from obsessive behaviors.	✓ The use of EBA can be limited by the practitioners to prevent children from obsessive behaviors towards to tablets. To do that, parent control service of the EBA should be activated by the practitioners.
6	The application should include help documentation for the practitioners.	✓ The EBA includes both informative texts and help-documents. Informative texts guide practitioners while preparing EBA for use. ✓ The EBA also includes two types of help documents. First one is user manual of the EBA which is presented on the login page. This manual prepared in an interactive form and includes help documents supported with both illustrations and videos. The second one, on the other hand, includes help documents regarding how to implement the EBA. In this part, implementation

	procedure was presented with visuals and informative texts.

4.3. Research Question 3: Functional Communication Data

In this section, functional communication data were presented for the following items;

- Task 1: “use of EBA for requesting after physically assistance”
- Task 2: “spontaneous use of EBA for requesting”
- Task 3: “simultaneous simple discrimination of pictures for requesting”
- Task 4: “simultaneous conditional discrimination of pictures for requesting”
- Task 5: “use of sentence structure for requesting”

The functional communication was defined as a series of communication acts by which individuals with communication impairments express their needs by using EBA. It starts with holding the tablet, approaching to the communication partner with the tablet, and using the tablet to express their needs. The functional communication data were illustrated on the Figure 4.6, Figure 4.7, and Figure 4.8 for each participant separately. The vertical axis of the graphs shows the participants’ overall percentage of correct responses during the treatment sessions; the horizontal axis of the graphs shows both functional and requesting data throughout the process.

4.3.1. Functional Communication Data of First Participant, EB

The first participant EB’s percentage of correct responses during the intervention and follow-up sessions are shown on Figure 4.6. Sections from Tasks 1 to Task 5 include intervention session data, the follow-up session was located to the end of the graphic. Before starting to the intervention sessions, a treatment related to the target task was conducted.

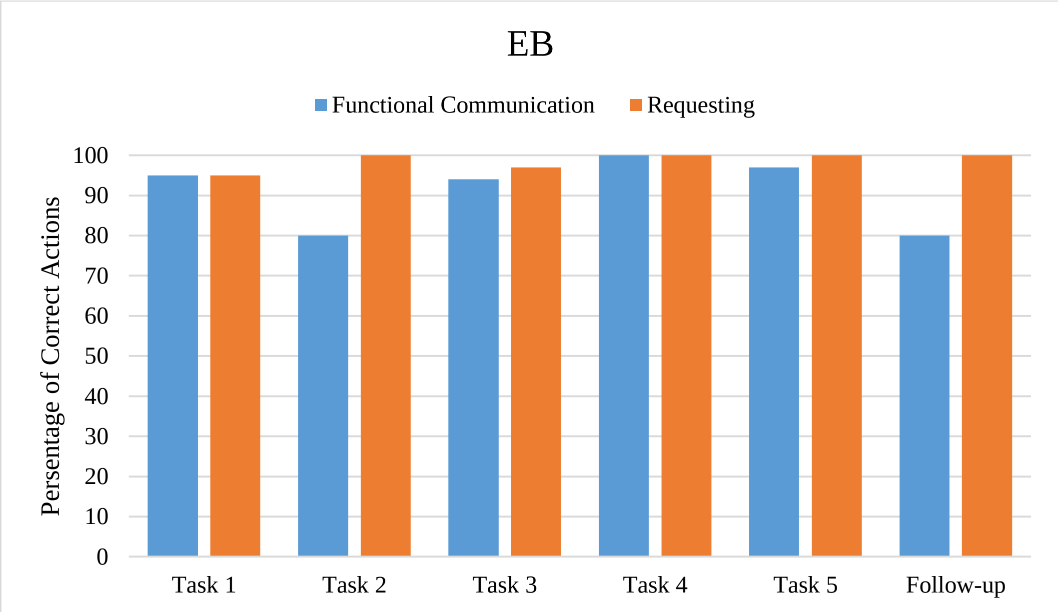


Figure 4.6. First Participant, EB's Percentage of Correct Actions throughout the Process

Four sessions were conducted for the first Task. The overall correct response of EB during the first task was 95%. Six sessions were conducted for the second task. As it can be inferred from the graph, EB performed 80% correct actions at the second task. He performed 95% correct response during the third task. During the fourth task the percentage of correct actions increased to 100%. He performed 97% correct response during the fifth task. However, he performed 80% correct response during the follow-up session.

4.3.1.1. Researchers Observations During the Sessions with EB

EB performed over than 80% correct response throughout the process. Although his functional data changed from 80% to 100%, his correct response for requesting was almost 100%. In other words, he learned to use EBA for both simple and multi-step requesting, but had difficulties within the functional communication context to some extent. This result indicates that EB leaned to associate touching a desired-object icon on the tablet screen to request a desired object, even if he did not hold the tablet or approach the communication partner. Additionally, during the task 5 sessions he started to imitate the sounds produced by the tablet. Especially, he pronounced the subject of the requesting sentence, “I”.

4.3.2. Functional Communication Data of Second Participant, HC

The second participant HC’s percentage of correct responses during the intervention and follow-up sessions are presented on Figure 4.7. Before starting to the intervention session, a treatment related to the target task was conducted.

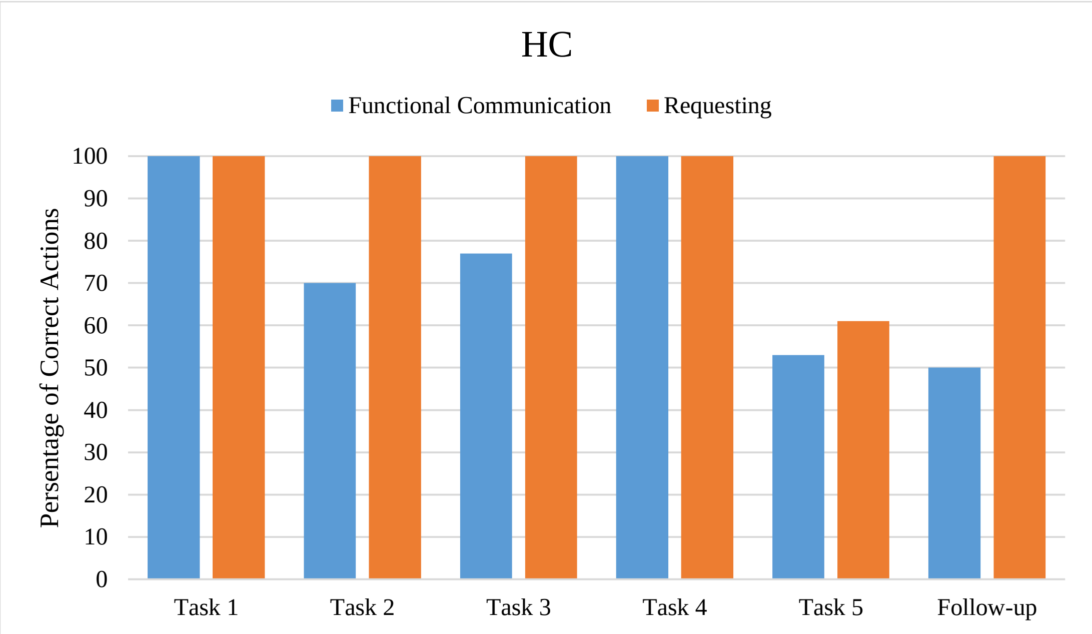


Figure 4.7. Second Participant HC’s Percentage of Correct Actions throughout the Process

As illustrated at Figure 4.7, HC’s overall correct responses at Task 1 was 100%, at Task 2 was 70%, at Task 3 was 77%, at Task 4 was 100% and at Task 5 was 53%. During the follow-up session he performed 50% accuracy. However, his correct responses for requesting data was 100%, except from the fifth task.

4.3.2.1. Researcher's Observation During the Sessions with HC

HC learned to express his needs by touching to the icons on the tablet easily. But he had difficulties in functional communication sub-tasks, which are holding the tablet and approaching to the communication partner. Most of the time he just touched to the desired-object icon on the tablet and approached to the communication partner to get the desired object without holding the tablet during the first four tasks. In this regard he learned requesting with the EBA, but not performed correct behaviors for functional communication.

Both task 5 and follow-up sessions were designed in a way that require multi-step requesting skills. HC had difficulties in multi-step requesting actions since he did not comprehend how to navigate the EBA in "building sentence structure" tasks. He was a bit nervous while touching to the tablet during the fifth task and follow-up sessions. This result might be related to the anxious about failure to get desired object. Furthermore, operational demands of multi-step requesting task might be inappropriate for HC.

4.3.3. Functional Communication Data of Second Participant, OFK

After the treatment, intervention sessions for five tasks were conducted. The third participant OFK's percentage of correct responses during the intervention and follow-up sessions are presented on Figure 4.8.

OFK's overall correct responses for functional communication was 100% at Task 1, 83% at Task 2, 86% at Task 3, and 100% at the following task and follow-up session. He performed high accuracy in all of the tasks requiring both simple and multi-step requesting.

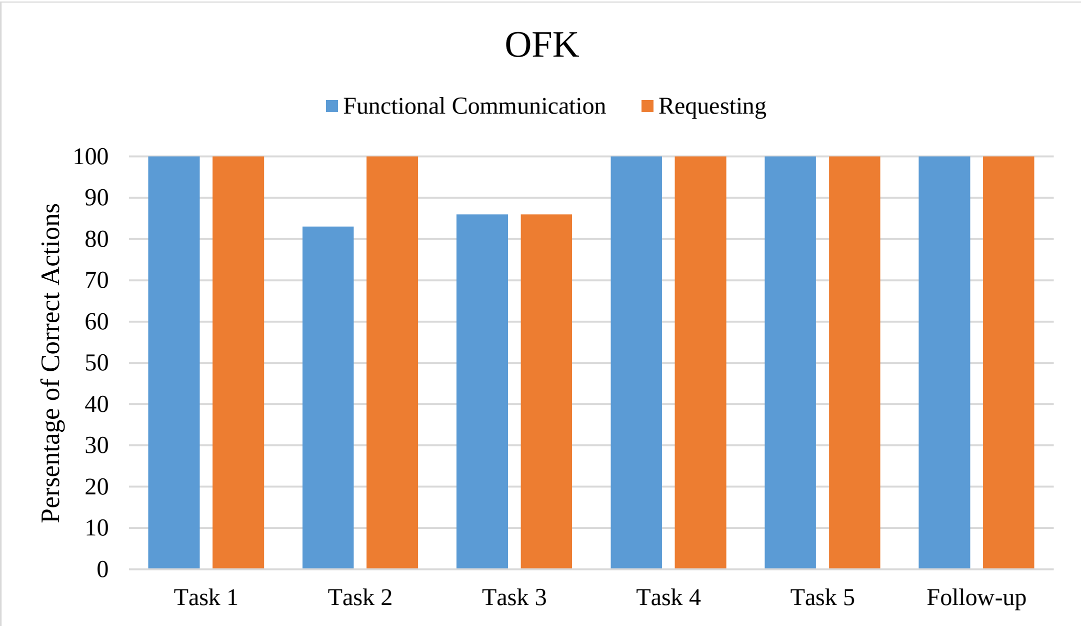


Figure 4.8. Third Participant OFK's Percentage of Correct Actions throughout the Process

4.3.3.1. Researchers' Observations During the Sessions with OFK

Both functional communication and requesting data of OFK was better than the other participants. Just like the other participants, his performance on requesting was higher than functional communication. He learned to operate the tablet for his communication needs easily. As far as we observed, his family took care him very much. They were trying to the same treatments at home. However, other participants were merely treated at the rehabilitation centers.

4.4. Research Question 3.1: Requesting Data for Each Participant

The EBA application was used as an assistive technology for requesting a desired objet. In order to do that, children need to touch the items that are connected with the desired object on the EBA application. In this section, the data addressing the requesting action was presented for each participant. It was also provided the response rate of other actions of participants while requesting an object.

4.4.1. Requesting Data of Participants During the First Task

After the first task's treatment, participants were observed whether they used the EBA for requesting or not. Four intervention sessions including five implementations were conducted with each participant. Analysis results indicated that the mean value of each participant for requesting during the first task was higher than .95. As shown Table 4.17, EB's mean value was .95, which means he performed 19 correct responses over 20 implementations. Additionally, the mean value of both HC and OFK for requesting was 1.00. In other words, they could be able to use EBA application in each implementation for requesting.

Table 4.17. *Requesting Data of Participants during the First Task*

		EB	HC	OFK
Tasks	Sub-task	Mean	Mean	Mean
Task 1	Touch the picture on the tablet for requesting	0.95	1.00	1.00

4.4.2. Requesting Data of Participants during the Second Task

The second task, which aimed to test spontaneous use of EBA application for requesting, was consisting of three subtasks (see Table 4.18). It was expected from the participants to make request in three cases. During the first case (S1), participants communicated with a certain partner who was sitting on a desk. During the second case (S2), participants communicated with a certain partner who was waiting a different place on the room. Finally, during the last case (S3), participants communicated with a different partner who was waiting a different place on the room.

Table 4.18. *Participants Actions during the Second Task*

		EB	HC	OFK

Tasks	Actions	Mean	Mean	Mean
S1	Hold the tablet from a different place on the room.	.80	.60	.50
	Approach the communication partner sitting on the table with the tablet	1.00	1.00	.70
	Touch the desired object's picture on the tablet	1.00	1.00	1.00
S2	Hold the tablet from a different place on the room.	.80	.70	1.00
	Approach the communication partner waiting a different place in the room	1.00	1.00	1.00
	Touch the desired object's picture on the tablet	1.00	1.00	1.00
S3	Hold the tablet from a different place on the room.	1.00	.80	1.00
	Approach a different communication partner waiting a different place in the room	.80	1.00	1.00
	Touch the desired object's picture on the tablet	1.00	1.00	1.00

The mean values of each action of participants were presented at Table 4.18. The third action ("*Touch the desired object's picture on the tablet*") on each subtask addresses the use of EBA merely for requesting. As it can be inferred from the table, each participant performed correct actions for requesting. Although there are different mean values for other actions of participants, the mean value of each participant was 1.00 for requesting.

4.4.3. Requesting Data of Participants during the Third Task

The third task includes simultaneous simple discrimination of pictures for requesting in three cases as in previous task. Participants were expected to communicate a partner by discriminating the contextually appropriate picture on the EBA. Table 4.19 shows the mean value of each actions of the participants. The third action ("*Discriminate the desired object ... and touch it*.") of each subtask on the table refers to requesting data.

Table 4.19. *Participants Actions during the Third Task*

Tasks	Actions	EB Mean	HC Mean	OFK Mean
S1	Hold the tablet from a different place on the room.	1.00	.80	1.00
	Approach the communication partner waiting a different place on the room.	1.00	1.00	1.00
	Discriminate the desired object between *two pictures* (one is contextually appropriate, the other one is non-preferred) on the tablet and touch it.	.90	1.00	.80
S2	Hold the tablet from a different place on the room.	1.00	.70	1.00
	Approach a *different* communication partner waiting a different place on the room	.95	1.00	1.00
	Discriminate the desired object between two pictures (one is contextually appropriate, the other one is non-preferred) on the tablet and touch it.	1.00	1.00	.95
S3	Hold the tablet from a different place on the room.	1.00	1.00	1.00

	Approach a different communication partner waiting a different place on the room	1.00	1.00	1.00
	Discriminate the desired object *among three or more pictures* (one is contextually appropriate, the others are non-preferred) on the tablet and touch it.	1.00	1.00	1.00

During the first subtask; EB's mean value for requesting was .90, HC's mean value was 1.00, and finally OFK's mean value was .60. These values were changed during the second subtask to a large extent. Accordingly, EB's mean value was 1.00; HC's mean value was 1.00; and OFK's mean value was .95. At the last subtask, each participant's mean value for requesting was 1.00.

4.4.4. Requesting Data of Participants during the Fourth Task

The fourth task includes simultaneous conditional discrimination of pictures for requesting in two cases. In this regard, participants were expected to discriminate contextually appropriate pictures for requesting on the EBA application. Participants actions and mean values during these cases were presented at Table 4.20. The third action ("*Discriminate the desired object ... and touch it*.") for each subtask on the table addresses the requesting mean value. As it can be inferred from the table all of the participants' mean value for requesting was 1.00.

Table 4.20. *Participants Actions during the Fourth Task*

Tasks	Actions	EB	HC	OFK
		Mean	Mean	Mean
S1	Hold the tablet from a different place on the room.	1.00	1.00	1.00

	Approach a different communication partner waiting a different place on the room.	1.00	1.00	1.00
	Discriminate the desired object between *two pictures* (*both of the objects are contextually appropriate*) and touch it.	1.00	1.00	1.00
S2	Hold the tablet from a different place on the room.	1.00	1.00	1.00
	Approach a different communication partner waiting a different place on the room.	1.00	1.00	1.00
	Discriminate the desired object *among three or more* pictures (*all of the objects are contextually appropriate*) and touch it.	1.00	1.00	1.00

4.4.5. Requesting Data of Participants during the Fifth Task

The final task includes the use of sentence structure for requesting. Participants action during this task were presented at Table 4.21. Third ("*Select the sentence structure icon on the tablet screen*") and fourth ("*Discriminate the desired object among several pictures and touch it*") actions on the table were directly related to the use of EBA for requesting. Therefore, they were presented as requesting data in this section. Accordingly, mean values of both EB and OFK for third and fourth actions were 1.00. However, HC's mean value for third action was .61. On the other hand, his mean value for the fourth action was 1.00.

Table 4.21. *Participants Actions during the Fourth Task*

Tasks	Actions	EB Mean	HC Mean	OFK Mean
Task 5	Hold the tablet from a place on the room.	.97	.92	1.00

Approach any communication partner waiting a different place on the room.	1.00	1.00	1.00
Select the sentence structure icon on the tablet screen	1.00	.61	1.00
Discriminate the desired object among several pictures and touch it.	1.00	1.00	1.00

4.5. Refinements on Design Principles after the Implementation of EBA

Several design principles derived from the analysis and prototyping procedures were presented previous sections. The EBA application was designed and developed based on such principles. It was implemented in the field to test its effectiveness in terms of functional communication. The results of this implementation were presented previous section as well. In this section refinements on the EBA were presented depending on the results regarding requesting data and researcher's experience during the implementation.

As illustrated on the Figure 4.6, Figure 4.7, and Figure 4.8, EB and OFK performed 100% correct actions during the fifth intervention session. However, at the beginning of fifth intervention HC did not performed any correct actions. This result also matched with the requesting data of HC during the fifth task. The mean value of third action during the fifth task was .61. When the action rate of the HC was examined during the fifth task intervention, it was clear that HC had difficulties on the task that required multiple-requesting steps. In other words, as indicated previous sections, in order to open sentence structure on EBA, user need to touch the category icon. After that, two icons addressing "objects" and "sentence structure" is appeared on the selected icon. What is expected from the users is that they should touch the "sentence structure" icon to build a sentence. In the main study, although the child touched correct category icon, he confused with the options appeared on the category icon. Therefore, in order to avoid such kind of contradiction, the application should be designed in a way that users can reach what they want in a simple manner. In other words, for the ones who have difficulties in multi-step requesting ability, the system should provide an option to decrease the number of multi-tasks for simple step requesting.

CHAPTER 5

DISCUSSION AND CONCLUSION

The main purpose of this study is to investigate the design, development, and implementation of an application-based high-tech aided AAC system for individuals with ASD. In more lay terms, present study examines the design specifications of mobile AAC applications and the effectiveness of proposed application (EBA) in functional communication and requesting skills. The term *design specification* is used to determine design issues including appealing, functionality, flexibility, and usability of the AAC system. Additionally, *effectiveness* refers to the frequency of correct responses of children in functional communication and requesting.

In order to seek the research questions, a design based research framework was employed proposed by Reeves (2000) and Reeves et al., (2004). Unlike other research methods, DBR includes multiple research designs either qualitative and quantitative or both of them. In this sense, the present study was divided into analysis, prototyping, and evaluation phases. In analysis phase, literature review and focus group analysis were conducted. In prototyping process, two expert review analyses were conducted with special education teachers and academicians in special education field. Finally, the EBA was tested in the field with three children with ASD in evaluation phase. Throughout the process, four types of data were collected including teachers' opinions about mobile technology usage, design principles, functional communication and requesting data. Furthermore, the implementation of the design principles was also illustrated on a prototype during the development process of the EBA.

To conclude, analysis results are divided into two parts. The first part is related to the design specification proposed for high-tech AAC devices. In this part, six main principles including a number of sub-principles were presented as follows:

1. The most remarkable principle was that the application should be personalized and customized depending on the individual differences.

2. The screen should be simple which implies the absence of distracting stimulus.

3. Visuals should support multiple color options and be presented with an appropriate instructional strategy. For example, increasing the number of visuals on the screen make easier to learn concepts.

4. The application should be programmed with natural digitized sounds.

5. In order to prevent children from obsessive behaviors, the application should include practical solutions.

6. To make the application more usable and familiar for children and practitioners, the system should be equipped with appropriate feedbacks and help documents.

The second part, on the other hand, includes functional communication data. In this regard, five main tasks were identified before, based on the related studies in the literature including, (1) use of EBA for requesting after getting physically assistance, (2) spontaneous use of EBA, (3) simultaneous simple discrimination of pictures, (4) simultaneous conditional discrimination of pictures, (5) using sentences structure for requesting. These five tasks include a group of subtasks ultimately aim to acquire requesting skill. In this regard, the overall correct responses in functional communication were 93% for EB, 74% for HC, and 93% for OFK. Additionally, the mean score of correct actions for requesting was .89 for EB, 1.00 for HC, and .86 for OFK.

5.1. Design Specifications of EBA: Second Research Question

Design specifications proposed in present study covers several guidelines to make mobile AAC applications more functional and appealing for individuals with communication impairments and practitioners. In this regard, six main design principles were presented in the current study. The first principle insists that the application should be personalized according to special needs of individuals with ASD. This principle requires customization of colors, visuals and sounds based on the characteristics of the user. There might be several implementations of this principle while designing an AAC application. The present study suggests making the application more personalized by adding *user account* feature to the system. All the specializations can be defined and adjusted on the selected account. For example, (1) the theme of the application can be customized by selecting appropriate color, (2) visuals can be resized and relocated on the screen, (3) digitized natural sounds can be rerecorded according to special needs of individuals. Furthermore, it provides a good opportunity for practitioners or families to track children communication acts by following the log files embedded to the application. Consequently, all these facilities provided on a user account require just-in-time programming of the application, and therefore ensure the flexibility and the functionality of the system.

The literature also supports the idea of implementing the first principle in AAC systems. According to Light and Drager (2002), and Light et al., (2007), while designing AAC applications, individual differences need to be taking into account. This is because; every individual in ASD is different than others including their preferences, priorities, and language and cultural demands (Schultz, 2005; Warren et al., 2011). Therefore, the diversity in their individual needs require flexibility in AAC design by offering multiple color option (Light et al., 2004), personalized themes (Light et al., 2004; Light et al., 2007), and different speech outputs (Drager et al., 2006; Light et al., 2004). The flexibility of the system should also contribute to capture and sustain users' attention (Light & Drager, 2002). Furthermore, all these customizations require just in time programming of the application (Beukelman et al., 1991; Caron et al., 2017; Holyfield et al., 2018; Holyfield, Drager, Light, & Caron, 2017b; Schlosser et al., 2016).

The second principle proposed in present study is related to the screen design of AAC applications, which requires absence of distracting stimulus. In this regard, current study offers several suggestions based on the analysis results including (1) the screen should be an optimal size, (2) the application should run on full-screen mode, (3) the background of the application should be bright and simple, and (4) additional media should be removed from the screen except from navigation bar and layout of the concepts. Simple design makes the application more usable and decreases the operational demands of application. In this sense, proposed suggestions are consistent with the related literature as stated; the operational demands of the system should be simple (Caron et al., 2017, 2016; Holyfield et al., 2017b) and the system should be usable for children and practitioners (Light & Drager, 2002).

The principles presented in current study were implemented on a touchscreen based mobile application and tested during a communication treatment. While designing the treatment, instructional strategies and implementation guidelines of PECS protocols (Bondy & Frost, 1994) were used with several modification as suggested by Genç-Tosun and Kurt, (2017a). The treatment procedure of the PECS begins functional communication with a simple picture-card and the numbers of the cards are increased gradually. Likewise, the third design principle insists the use of (1) visuals with an instructional strategy (2) with color customization. (3) Additionally, once users touch the visual, the system should provide an immediate feedback by generating a sound output. Similar results were also expressed in the literature. Accordingly, the visuals used on the high-tech AAC systems should support bright and light colors (Light et al., 2004; Light et al., 2007). These visuals consist of the main communication concepts. Therefore, when the user initiates communication through these concepts the systems should provide immediate feedback to the users' each action (Light et al., 2004).

Individuals using AAC systems generally gets language inputs through spoken language, but the type of language output can vary (Light, 1997). Both screen display visuals, and digitized and synthetic sounds would be a language output of a AAC system (Light & Drager, 2007). In this regard, intangibility of the language output is so crucial for individuals using AAC to express their needs. Contrary to using merely visuals, sounds and sounds with visual cues provide more valid intangibility result. Additionally, the type of the sounds, whether it is digitized or synthetic, may also affect that results. In this sense, present study supports the use of both contextual information (through visuals) and sounds as an output channel concurrently as emphasized by many researchers (Drager et al., 2006; Mirenda & Beukelman, 1987). Although there is no clear evidence about the effectiveness of speech type on intangibility, digitized sounds are more preferable than synthetic sounds since they are so close to natural human voice (Schlosser & Koul, 2015). Similarly, present study suggests using digitized speech output on high-tech AAC systems. By means of that, people close to individuals using AAC can record communication concepts. Furthermore, there need adjustments on the digitized sounds to make them more socially acceptable. In doing so, the grammar of the language need to be considered. For example, an advance sound setting feature was added to the EBA application on which users have opportunity to omit the subject of sentence in accordance with the common usage in Turkish context.

Individuals with ASD generally adhere to certain routines strictly in daily life, which may cause selectivity and hence development of obsessive behaviors (Hyman & Levy, 2013). This result was also emphasized by special education teachers during the analysis phase of problem situation. They also concern about the misemployment of the EBA, especially during the treatment. Therefore, the present study suggests additional functions on AAC systems to keep individual with ASD from abnormal behaviors. One practical solution offered on the EBA is the use of *parent control* feature. This control gives opportunity to the parents to preclude their children from obsessive behaviors. However, this result might be arguable because the ultimate goal of the EBA is to enhance functional communication and individuals may need communication in anytime and anywhere. Making restricting in communication may cause ethical problems as well. Therefore, this feature might be used merely during the treatment to control the process and should be optional.

A high-tech AAC system requires operational demands. Parents and practitioners, especially, take part in the programming steps of the application and are exposed to such operational demands. In order to fulfill these demands successfully, they need to experience with the system in advance. In case of having trouble with the system, the user should be directed to the correct actions by providing appropriate feedback. Nevertheless, a typical user may need help-documentation so that they become more experienced with the system (Nielsen, 1993). Therefore, help documents need to be embedded to the application to illustrate the programming steps of the application and treatment procedure.

5.2. Effectiveness of EBA: Third Research Question

Before collecting effectiveness data of the EBA, design specifications for high-tech AAC applications were derived from focus group and expert review analysis results. Meanwhile, these specifications were implemented on the EBA with practical solutions. After putting the EBA into final form, it was implemented in the field with three children (EB, HC, OFK). All of the participants were diagnosed with ASD, have similar disability rate (two of them have %40 disability rate, the other one has %70), same gender, and similar educational and family backgrounds. Five main *functional communication* tasks including several subtasks were identified before conducting the treatment. The last subtask of each task refers to *requesting* a desired object. Accordingly, two types of effectiveness data were collected: functional communication and more specifically requesting. During the intervention sessions, a similar procedure to PECS protocols (Bondy & Frost, 1994) were employed.

The first task was the *use of EBA for requesting with a single picture card* after getting a treatment including physical prompt without verbal cues. The correct action of EB was 95%, HC was 100%, and OFK was 100% during the first task. Two additional manipulations were added to the second task to make the communication more *spontaneous*. The total correct response of EB was 94%, HC was 70%, and OFK was 83% during the second task. In the third task, a new neutral communication card was added to the application to teach *simple discrimination* of communication concepts. Error correction strategy was also employed during this phase. Accordingly, the correct response of EB was 94%, HC was 77%, and OFK was 86%. The natural communication concept was removed from the EBA and new communication concepts corresponding new desired objects were added to the EBA to teach *conditional discrimination* in the fourth task. In this regard, the correct response of EB was 100%, HC was 87%, and OFK was 100%. Finally, a sentence structure including *multiple requesting* skills was employed during the last task. The correct response of EB was 100%, HC was 53%, and OFK was 100%. Consequently, the overall correct response of EB was 93%, HC was 74%, and OFK was 93% throughout the process.

The functional communication data presented in current study supports the arguments provided at previous studies. Accordingly, individuals with ASD or communication impairments have confirmed remarkable gains in functional communication skills by using low-tech aided AAC (Bondy & Frost, 1994; Hart & Banda, 2009; Sulzer-Azaroff et al., 2009; Tien, 2008) and high-tech aided AAC (Lorah et al., 2015; Nepo et al., 2017; van der Meer et al., 2011; van der Meer & Rispoli, 2010) For example, Sulzer-Azaroff et al., (2009) investigated to the effectiveness of PECS on functional communication for individuals with communication impairments. They provided in-depth analysis of the PECS implementation in the field and showed improvement in communication skills of both children and adults after adhering PECS protocols (Sulzer-Azaroff et al., 2009). Furthermore, 62% of the studies reviewed by Tien (2008) reported increase in language and communication level after taking PECS treatment. Likewise, van der Meer and Rispoli (2010) reviewed the SGD literature and concluded that 82% of the studies they reviewed reported positive outcomes in terms of functional communication.

The requesting data were collected when children with ASD interact with the EBA. From this point of view, it includes both simple and multiple requesting actions of participants. While the first four tasks demand simple requesting, the last task includes multiple requesting. Accordingly, at the end of the first task the mean score of EB was .95, HC was 1.00, and OFK was 1.00 for requesting. Additionally, all of the participants mean score was 1.00 for requesting during the second task. Furthermore, the mean score of EB was .96, HC was 1.00, and OFK was .85 during the third task. Moreover, the mean score of each participant was 1.00 during the fourth task. Finally, the mean score of both EB and OFK were 1.00, but HC was .80 during the last task, which also implies the multiple requesting score of participants. On the other hand, the overall simple requesting mean score of EB was .98, HC was 1.00, and OFK was .96.

The present study showed remarkable increase in both simple and multiple requesting skills for each participant. This result confirms the previous results in the AAC literature (Alzrayer et al., 2017; An et al., 2017; Genc-Tosun & Kurt, 2017b). For example, An et al., (2017) developed a mobile application named “Yuudee" to promote communication skills of individuals who have limited verbal language. Yuudee was designed in a way that supports both Android and IOS platforms. It has 39 categories with over than 400 pictures corresponding the verbal phrases. The application can be administrated from parent, trainer, and children mode. It has several functions which are picture selection on the tablet screen, adding new pictures and categories, and disabling the speech output. They tested the effectiveness of Yuudee in the field by following the instructional strategies of PECS protocols. Consequently, they reported increase in both simple and multiple requesting skills.

The number of studies investigating multiple requesting skills was increased in recent years (Schlosser & Koul, 2015). Genc-Tosun & Kurt, (2017b) showed that children with ASD can be able to learn multi-step navigating skills to initiate communication. However, contrary to simple requesting, it demands more effort to initiate the communication. In present study, both EB and OFK obtained higher multiple requesting mean score than simple requesting. However, a large decrease in multiple requesting mean score of HC was observed. This result might be explained with the disability rate of the participants.

5.3. Functionality of the EBA in Special Learning

The question that how children with special needs learn is an important concern to which researchers need to pay more attention. This requires a comprehensive elaboration of both learning and instructional theories by considering special needs of the individuals. Cognitive theories, for example, lay emphasize on cognitive process in the mind and account for learning process with perception and memory models. More specifically, it tries to understand the relationship between mental processes and task performance, and the constraints having influence on information processing of children with disabilities (Swanson, 1987). Likewise, Norman (1968) proposed a theoretical framework to explain how information is transferred in the mind. The framework focused on the four essential components in information processing which are input, perception, attention and memory. Although, the memory models are not well-suited in information processing for children with disabilities (Swanson, 1987), the EBA may add value in the implementation of these components for individuals with ASD.

Information as an input first processed by the sensory memory (Baddeley, Eysenck, & Anderson, 2009). It is emphasized in the literature that the number of the senses being employed during the learning makes easier the integrating of input to the working memory (Campigotto et al., 2013). Although information processing theory mainly focus on visual and auditory inputs, use of five senses is suggested in the message design to ensure meaningful learning (Grabowski, 1991). In this regard, in addition to the visual and auditory inputs, the EBA has potential to trigger the sense of touch during the learning activities.

Attention deficit is commonly observed problem on individuals with ASD. Holmes et al., (2010) associated this problem with poor working memory capability at children with attention deficit. But it could be enhanced by training working memory (Holmes et al., 2010; Klingberg et al., 2005). In this regard, mobile technologies provides several opportunities not only to gain students' interest but also to foster their learning (Fernández-López et al., 2013). Additionally, light and bright colors might be used on the instructional materials to catch children's attention (Light et al., 2004). In this sense, the EBA offers several features to take learners attention. Almost all of the features of EBA can be customized depending on the characteristics of learners in a way that may catch and sustain children's attention.

The working memory has limited capacity in nature (Mayer, 2001; Mayer & Moreno, 2010; Sweller, 2005). While designing an instruction or an instructional material such restriction need to be taken into account to increase their effectiveness (Bannert, 2002; Sweller, 2005). Different strategies including segmenting, sequencing and pre-training might be used to facilitate the essential processing in the working memory (Clark, Nguyen, & Sweller, 2006). In this regard, the EBA was designed by considering the characteristics of working memory and proposed strategies. In other words, the communication act was divided into simple and multiple requesting. Several features were added to the EBA to fulfill both of these acts. Users who have difficulties in multiple navigating skills and thereby in multiple requesting can use the simple requesting for communication by using the *learning objects* options on the selected category. Once they become experienced with the multiple navigating skills in time, they may use the *sentence structure* option as well.

5.4. Generalization of the Results

The present study includes both qualitative and quantitative data. Generalization of qualitative data is an inherited debate in social sciences. According to Patton (2002), generalizability of the findings depends on selected qualitative framework and criteria. Because the term *generalizability* implies quantitative research design, alternative terms including *transferability* (Patton, 2002) or *replicability* (Fraenkel, Wallen, & Hyun, 2012) can be used in a qualitative method. Additionally, the context and the participants of the study need to be described in detail (Creswell, 2007), and data collection methods need to be varied (Miles & Huberman, 1994; Patton, 2002).

Design-based research framework was employed in current study which demands multiple inquiry (Collins, Joseph, & Bielaczyc, 2004; Design-Based Research Collective., 2003; Wang & Hannafin, 2005). As a result of that different data collection methods were used throughout the study. The characteristics of the participants and the detail of the settings were presented at the method chapter. Consequently, qualitative results (design principles) of the study also match up with the arguments in the literature as detailed previous part. Additionally, certain design principles for AAC application and features of the EBA might be special for Turkish contexts.

In order to ensure generalizability of quantitative data, a generalization session was conducted with the participants. This session was organized based on fifth task detailed previous sections, which demands a group of functional communication subtask addressing to multiple requesting. The percentage of correct responses of EB was 80, HC was 50, and OFK was 100. In other words, while two of the participants (EB and OFK) completed the task successfully and increased multiple requesting skills with EBA, the other participant (HC) had difficulties in that. This result might be related to the disability rate and chronological age of HC since the disability rate and age of the HC were higher than others.

5.5. Validity and Reliability of the Study

As mentioned previous part, two types of data were collected in present study: qualitative and quantitative. In order to increase the credibility of the qualitative data, different strategies were employed including triangulation and inter-rater agreement. The term *triangulation* refers to use of multiple sources to confirm the results

(Creswell, 2007; Miles & Huberman, 1994; Patton, 2002). There are four ways of doing triangulation including method, source, analyst, and theory or perspective triangulation (Patton, 2002). In order to verify the qualitative results; method, source, and analyst triangulations techniques were used in present study. Due to the by default nature of DBR, multiple methods were used in the analysis phase of the study including focus group, in depth interview, and content analysis. Additionally, data sources were also varied throughout the process. Parents, special education teachers, experts, and academicians took part in the study periodically. Finally, in order to ensure inter-coder agreement firstly codes and themes were checked by a special education expert and an academician from educational sciences. Then, based on their feedbacks, several revisions were made on codes and themes. The ultimate version of codes and themes were checked by two instructional technologists. Accordingly, the percentage agreement on initial codes and evaluated codes was 95%, and initial themes and evaluated themes was 89.3%.

Social validity is also an important concern in applied behavior analysis (Baer et al., 1968), which refers to "*assessing the social acceptability of an intervention program*" (Kazdin, 1977, p.430). In this regard, (1) the goal or the focus of the intervention should be important for society, (2) the treatment procedure should be acceptable in the society, and (3) the behavior change should satisfy in the society (Kazdin, 1977; Wolf, 1978). In order to assess the validation of treatment, two evaluation methods were proposed: *subjective evaluation* and *social comparison* (Kazdin, 1977; Wolf, 1978). *Subjective evaluation* requires the assessment of goal, procedure, and behavior change by individuals who have opportunity to contact with individuals who are under observation (Wolf, 1978). *Social comparison*, on the other hand, focuses on the behavior change after the treatment by comparing non-deviant peers' behavior (Kazdin, 1977).

Subjective evaluation method was used to some extent in present study. During the focus group analysis, special education teachers were asked to use of touchscreen based mobile devices in communication. They almost stated their positive attitudes toward the use such devices. However, this result should have confirmed after the treatment with EBA. Unfortunately, both special education teachers' and parents' views about the use of EBA was not obtained after the intervention. Nevertheless, many of the similar studies have reported positive opinions of the parents and special education teachers (Genc-Tosun & Kurt, 2017; Meder & Wegner, 2015).

5.6. Originality of the Study

The present study is the first study focusing on the design specifications of mobile applications for communication needs of individuals with ASD in Turkey. In order to confirm this result, a search was performed on *Web of Science* by using the following combination of keywords, Topic = (design OR "design principles" OR "design specifications") AND ("AAC" OR "alternative and augmentative communication") in September, 2018. Accordingly, 884 results were yielded by this approach. These results were refined with the criteria that Countries/Region = (Turkey) and Web of Science Categories = (Education Special). As a result, we reached only one study conducted by Genç-Tosun & Kurt (2017b). However, the scope of this study was the use of SGDs in special education with methodological concerns. Therefore, this study is the first study investigating the design specification of AAC application in Turkey.

The study provides practical solutions towards to use of proposed design principles on a concrete application, EBA. All of the analysis, design, and development process of the EBA were illustrated within a design based research framework. From this point of view, current study has value in converging theory and practice.

The present study is also one of the few studies investigating the high-tech AAC application on functional communication skills of individuals with ASD in Turkey. This result was also confirmed with a search in *Web of Science* including the combination of the following keywords, Topic = ("AAC" OR "Alternative and Augmentative Communication" OR "SGD") AND ("ASD" OR "autism spectrum disorder”) AND ("functional communication" OR "request*" OR "mand" OR "simple request*" OR "multiple request*") in September, 2018. These criteria yielded 45 results in general. Additional refinements were made on the criteria to examine the topic in Turkish context by adding a new criterion, Countries/Region = (Turkey). Accordingly, three studies (Ganz et al., 2017; Genc-Tosun & Kurt, 2017a; Morin et al., 2018) were listed after the refinements. As a result, it can be concluded that the present study is one of the pioneers in special education field in Turkey.

5.7. Implications for Practitioners

The present study provides several practical implications for parents and special education teachers based on the research results and experience of the researcher. Both parents and practitioners can use the EBA application to teach functional communication skills for individuals with ASD. The following guidelines are suggested while using the EBA:

1. The application is suitable for individuals who are diagnosed with ASD or communication impairments and who meet the following criteria: (a) ability to use hands, fingers and fine motor controls (Romski & Sevcik, 2005), and (b) ability to focus on a specific task for a while.

2. Designing a communication treatment requires a teamwork (ASHA, 1992) in which all the stakeholders work collaboratively. Therefore, if possible, parents, special education teachers and speech language pathologists should take part in the process.

3. Before the intervention, detail information (e.g., needs, favorable colors, voices) about the participant need to be collected (National Joint Committee for the Communication Needs of Persons With Severe Disabilities (ASHA), 1992).

4. The application should be personalized by taking participants' characteristics into account (e.g., creating user account, adjusting themes or colors).

5. Before starting to the treatment, a preference assessment needs to be conducted to determine the desired objects (reinforcements) (Sulzer-Azaroff et al., 2009). Some of the participants might be allergic to certain objects (e.g., candy), these objects need to be removed from the reinforcement list.

6. Communication is a by default need of people, therefore it is a requirement to give chance participants to initiate the communication in a natural context.

7. Verbal cues or prompts should not be given to the participants during the treatment (Bondy & Frost, 1994, 2001; Hart & Banda, 2009).

8. Physical prompts can be used at the beginning of the treatment, once the participant starts to use application, these prompts should be faded (Bondy & Frost, 1994, 2001).

9. Different instructional strategies including time delay, error correction procedure, and reinforcement can be used during the treatment.

10. Using the mobile device (in this case tablet) with an interesting case not only take participants attention but also take precaution against to damage of the device.

11. Correct actions of the participants should be reinforced immediately.

5.8. Limitations of the Study

There are several limitations of the current study. The first limitation is related to the methodological concerns. Firstly, design based researches are conducted in a specific context, therefore the external validity or generalizability of the results is usually limited (Richey & Klein, 2005). Additionally, while selecting the participants homogeneous purposive sampling technique was employed in the study. Design specification of the AAC systems were derived from the data collected from special education teachers, an expert, and academicians. However, because special education teachers and the expert did not experience with any AAC system before, the quality of the data they provided might be arguable. Therefore, while selecting the participants, criterion based purposive sampling method should be used to reach information-rich cases (Patton, 1990). Furthermore, only three children with ASD took part in the evaluation phase of the study. Both the number of the children and the focus on ASD might be a limitation in the study. Finally, there is no adequate social validity data to assess all the stakeholders' perspectives about the EBA implementation.

Single subject designs are most frequently preferred method to investigate the functional communication of individuals with severe communication impairments. Although the several methods were used to control internal validity threats, the design is affected by internal validity threat in nature. Therefore, results of such studies should be interpreted as suggestive rather than conclusive (Mirenda, 2003). In this regard, a multiple baseline across participant design was tried to use in evaluation phase of the study to understand the effectiveness of the EBA. However, because we did not meet the criteria of the baseline condition, the treatment was implemented at intervention sessions without collecting baseline data. Therefore, the effectiveness data of both functional communication and requesting should be evaluated carefully.

5.9. Implications and Suggestions for Further Studies

Rapid developments in information technology have provided new directions for AAC interventions (Moffatt et al., 2017) in theory and practice (Meder & Wegner, 2015). Even though a variety of studies (Alzrayer et al., 2017; An et al., 2017; Chmiliar & Anton, 2015; Ganz et al., 2017, 2015; Lorah et al., 2015; Morin et al., 2018; Wojciechowski & Al-Musawi, 2017) have demonstrated the potential advantages of mobile devices as an assistive technology, there is still need more research to confirm these results (Ok, 2018) in different cultures and settings. Especially, there is no adequate research about the use of high-tech AAC systems for communication and their social validity in Turkey (Genç-Tosun & Kurt, 2017a).

Basic AAC interventions primarily aim to teach expressive language by teaching single step requesting skill for individuals with communication needs. However, use of high-tech AAC devices require several operational demands including switching on the device and lunching, navigating, and operating the application. In order to meet these demands, there is a paradigm shift from single step requesting to multi-step requesting in recent years (Schlosser & Koul, 2015). It also has a vital role in gaining more advance communication skills (Light, 1989). In this regard, few studies (Alzrayer et al., 2017; An et al., 2017; Genc-Tosun & Kurt, 2017a) have reported positive outcomes of use of SGDs in multi-step requesting (Schlosser & Koul, 2015). Therefore, there is need further studies to understand how to teach multi-step requesting skill via high-tech AAC devices for children with communication impairments.

Design specifications of AAC systems are also an important concern to which researchers need to pay more attention. The demand is to find more helpful systems which are easy to use, affordable, and appealing for children (Meder & Wegner, 2015), families and practitioners (Light & Drager, 2002). It is certain that these specifications may vary according to the characteristics of children including their needs, skills, and interests (Light & Drager, 2002). One way of doing that is to input these children into design and development process (Druin et al., 1998). However, few studies (Holyfield et al., 2017b; Light et al., 2007) have focused on design of the AAC systems within a participatory design framework so far. In this regard, the present study more specifically elaborated general design concerns of the high-tech AAC applications in accordance with the cultural demands of Turkish people. However, there are also many questions still need further investigation to reveal these concerns including;

appeal of the system, strategies to reduce learning demands of navigation systems, effective layout and organization methods, and output systems (Light & Drager, 2007).

An ideal high-teach AAC system should be usable (Light & Drager, 2002, 2007) for both children and practitioners. Because it requires fewer cognitive demands to use (Light & Drager, 2007), children with communication impairments may learn it easily (Caron et al., 2017). It also provides just-in-time programming opportunity for practitioners with fewer steps (Caron et al., 2017, 2016). Therefore, in order to reduce the operational demands of AAC applications there need usability guidelines. In this regard, Nielsen (1994) proposed several heuristics for user interface designs. However, there is also need further research to test these heuristics in designing high-tech AAC interfaces or to reveal new heuristics appropriate to the problem situation.

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APPENDICES

APPENDIX A

OFFICIAL PERMISSIONS FROM METU

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
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02 OCAK 2017

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Konu: Değerlendirme Sonucu

Gönderen: Prof. Dr. Canan SÜMER

İnsan Araştırmaları Etik Kurulu Başkanı

İlgi: Etik Onayı

Sayın Doç. Dr. Ömer DELİALİOĞLU;

Danışmanlığını yaptığınız Hamza POLAT' ın "***Otizmli Bireylere İletişim Becerisi Kazandırmaya Yönelik Mobil Uygulamaların Kullanımının Tasarım İlkeleri ile Birlikte İncelenmesi***" başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2016-EGT-178** protokol numarası ile **04.01.2017-30.10.2017** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Canan SÜMER

İnsan Araştırmaları Etik Kurulu Başkanı

UYGULAMALI ETİK ARAŞTIRMA MERKEZİ
APPLIED ETHICS RESEARCH CENTER

ORTA DOĞU TEKNİK ÜNİVERSİTESİ
MIDDLE EAST TECHNICAL UNIVERSITY

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Sayı: 28620816 / 599

15 ARALIK 2017

Konu: Değerlendirme Sonucu

Gönderen: ODTÜ İnsan Araştırmaları Etik Kurulu (İAEK)

İlgi: İnsan Araştırmaları Etik Kurulu Başvurusu

Sayın Doç.Dr.Ömer DELİALİOĞLU;

Danışmanlığını yaptığınız Hamza POLAT'ın **"Otizmli Bireylere İletişim Becerisi Kazandırmaya Yönelik Mobil Uygulamaların Kullanımının Tasarım İlkeleri ile Birlikte İncelenmesi"** başlıklı araştırması İnsan Araştırmaları Etik Kurulu tarafından uygun görülerek gerekli onay **2017-EGT-178** protokol numarası ile **15.12.2017-30.12.2018** tarihleri arasında geçerli olmak üzere verilmiştir.

Bilgilerinize saygılarımla sunarım.

Prof. Dr. Ş. Halil TURAN
Başkan V

Prof. Dr. Ayhan SOL
Üye

Prof. Dr. Ayhan Gürbüz DEMİR
Üye

Doç. Dr. Yaşar KONDAKÇI
Üye

Doç. Dr. Zana ÇITAK
Üye

Yrd. Doç. Dr. Pınar KAYGAN
Üye

Yrd. Doç. Dr. Emre SELÇUK
Üye

APPENDIX B

OFFICIAL PERMISSION FROM MINISTRY OF EDUCATION

T.C.
ERZİNCAN VALİLİĞİ
İl Millî Eğitim Müdürlüğü

Sayı : 45468433-44-E.2571752
Konu: Doktora Tez Çalışması

28.02.2017

ERZİNCAN ÜNİVERSİTESİ
(Eğitim Fakültesi Dekanlığı)

İlgi: 10.02.2017 tarihli ve 31609083-903.07.02-E.7828 sayılı yazınız.

Üniversiteniz Bilgisayar ve Eğitim Teknolojileri Eğitimi Bölümü öğretim elemanı Arş. Gör. Hamza POLAT'ın doktora tez çalışması yapmasına ilişkin; Müdürlük Makamının 27.02.2017 tarih ve 2505064 sayılı onayı ekte gönderilmiştir.

Söz konusu çalıma tamamlandıktan sonra, uygulama sonucunun 2 adet örnek CD ortamında hazırlanarak, Müdürlüğümüz Strateji Geliştirme Hizmetleri AR-GE birimine teslim edilmesi hususunda;

Bilgilerinizi ve gereğini arz ederim.

Aziz GÜN
İl Milli Eğitim Müdürü

EK: Onay (1-sayfa)

"Güvenli Elektronik İmzalı
Aslı İle Aynıdır.
28/02/2017"
Ercan ŞENER
V.H.K.İ.

T.C.
ERZİNCAN VALİLİĞİ
İl Millî Eğitim Müdürlüğü

Sayı : 45468433-44-E.2505064
Konu : Doktora Tez Çalışması

27.02.2017

MÜDÜRLÜK MAKAMINA

İlgi : a) Milli Eğitim Bakanlığı Yenilik ve Eğitim Teknolojileri Genel Müdürlüğünün 07.12.2014 tarihli ve 2012/13 numaralı Genelgesi.
b) Erzincan Üniversitesi Eğitim Fakültesi Dekanlığının 10.02.2017 tarih ve 31609083-903.07.02-E.7828 sayılı yazısı

Erzincan Üniversitesi Eğitim Fakültesi Dekanlığı Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü öğretim elemanlarından Arş. Gör. Hamza POLAT'ın **"Otizmli Bireylere İletişim Becerisi Kazandırmaya Yönelik Mobil Uygulamaların Kullanımının Tasarım İlkeleri İle Birlikte İncelenmesi"** konulu doktora tez çalışması yapmak istediğine ilişkin, ilgi (b) yazı ve eki araştırma çalışması ilişikte sunulmuştur.

İlgi (a) Genelge esaslarına göre "İl Milli Eğitim Anket-Araştırma-Tez Çalışmalarını Değerlendirme Komisyonu" tarafından incelenen ilgilinin doktora tez Erzincan Özel Eğitim Uygulama Merkezi I. Kademe ve Milli İrade Özel Eğitim Uygulama Merkezi ve İş Uygulama Merkezinde uygulaması Müdürlüğümüzce yerinde görülmektedir.

Makamlarınızca da uygun görüldüğü takdirde; onaylarınıza arz ederim.

Hasan GÜNEŞ
Şube Müdürü

OLUR
27.02.2017

Aziz GÜN
İl Milli Eğitim Müdürü

EKLER:
-Komisyon Kararı (1-sayfa)
-Yazı ve Ekleri (20-sayfa)

Mengüceli Mah. Kamu Lojmanları 1311. Sokak-ERZİNCAN
Elektronik Ağ::http://erzincan.meb.gov.tr
e-posta: arge24@meb.gov.tr

Ayrıntılı bilgi için: Hasan GÜNEŞ-Şube Müdürü
Tel: (0 446) 214 20 73-12 45
Faks: (0 446) 214 11 85

Bu evrak güvenli elektronik imza ile imzalanmıştır. http://evraksorgu.meb.gov.tr adresinden f44d-2bf1-38bf-9149-4ea0 kodu ile teyit edilebilir

APPENDIX C

FOCUS GROUP INTERVIEW PROTOCOL

Çalışma Başlığı	:	Otizmli bireylere iletişim becerisi kazandırmaya yönelik mobil uygulamaların kullanımının tasarım ilkeleri ile birlikte incelenmesi
Tarih / Saat	:	
Yer	:	
Görüşme Yapan Kişi	:	
Görüşülen Kişinin Pozisyonu	:	

Görüşme Planı		
Açılış		
Yakınlık Kurma	:	Merhabalar, adım Hamza. ODTU, Bilgisayar ve Öğretim Tek. Eğitimi Bölümünde, otizmli bireylerin ihtiyaçlarına uygun mobil uygulamalar üzerine çalışıyorum. Bu konuda sizden fikirleriniz bu bireylerin sorunlarını daha iyi anlama noktasında bize yardımcı olacak
Amaç	:	Görüşme süresince, özel eğitimdeki deneyiminiz ve bu alanla ilgi eğitim geçmişiniz çerçevesinde otizmli bireylerin günlük hayatta karşılaştığı bazı sorunlarla ilgili sorular yönelteceğim.
Motivasyon	:	Verdiğiniz bilgiler ışığında bu bireylerin sorunlarına yönelik mobil uygulama geliştireceğiz. Özel olarak, böyle bir uygulama akademik bakış açısıyla henüz Türkiye’de geliştirilmedi. Sizin yardımınızla, mobil uygulama şekillenecek ve belki de birçok otizmli bireyin günlük hayatta kullandığı vazgeçilmez bir araç olacak.

Zamanlama : 60dk sürmesi beklenen görüşmede yönlendireceğim sorulara cevap verebilirsiniz.

Gelişme

[Konu] Eğitim Durumu ve Tecrübe

Lisans eğitiminizi hangi alanda tamamladınız?

Lisans eğitimi boyunca otizmli bireyleri yakından tanımanıza yardımcı olacak dersler aldınız mı?

Kaç yıldır özel eğitimde çalışıyorsunuz?

Bu süreç içerisinde otizmli bireylerle karşılaştınız mı?

[Konu] Otizmli Bireyler

Aldığınız eğitim ve tecrübelerinize dayanarak otizmi nasıl tanımlarsınız?

Sizce otizmli bireylerin temel özellikleri nelerdir?

[Geçiş] Bildiğiniz gibi, Autism Spectrum Disorder (ASD), Amerikan Psikiyatri Birliği tarafından tanımlanan zihin gelişimiyle ilgili bir hasatlık. Beş tane tanı kriteri var. Bunlardan en önemlileri iletişim becerisi eksikliği ve art arda devam eden, normal olmayan davranışlar. Hatta bu davranışlarda kendilerini iyi ifade edemedikleri için ortaya çıktığı da söylenmekte.

[Konu] Otizmli Bireyler ve İletişim

Sizce otizmli bireylerde ne tür iletişim problemleri vardır?

Bu problemleri aşmak için var olan alternatif yöntemlerden kısaca bahseder misiniz?

Herhangi bir alternatif yöntemi kullandınız mı? Nasıl?

Sizce hangi yaş aralığı bu tür yöntemler için daha uygun olur? Neden?

[Konu] Mobil Teknolojilerin İletişim Amaçlı Kullanımı

Otizmli bireylerin tablet, akıllı telefon gibi mobile teknolojilere tepkisini nasıl değerlendirirsiniz?

Eğer gözlemleme fırsatı bulduysanız ya da ailelerinden gelen bilgiler doğrultusunda, bu bireyler ne tür uygulamalar ile zaman harcar?

Ortak özellikleri nelerdir?

Ne tür uygulamalar onlar için daha motive edicidir?

Otizmli bireylere iletişim becerisi kazandırmak için tasarlanan alternatif yöntemlerin mobil teknolojilere uyarlanmasını nasıl değerlendirirsiniz?

Bu tür uygulamalarla iletişim becerisi kazandırılabilir mi?

[Konu] Uygulama Tasarım İlkeleri

Otizmli bireylerin temel iletişim becerisi kazanımını düşündüğünüzde, örneğin “ben oyuncak istiyorum” gibi kısaca kendini ifade edebileceği bir kazanım için geliştirilecek bir mobil uygulamanın nasıl olmasını beklersiniz?

Mobil uygulamanın, gerçek resim nesneleri ve bu bireylere yakın kişilerin seslendirmeleriyle desteklenmesi, bu bireylerin iletişim becerisini kazanmasına herhangi bir etkisi olabilir mi?

Tasarımsal olarak düşündüğünüzde, bu uygulamaların bu bireylerin gelişim seviyesine uygun olabilmesi için neler içermesi sizce uygun olur? Örneğin ekran boyutu, ekranın sadeliği, renkler vb.

Yine tasarımsal olarak böyle bir uygulamada sizin önceliğiniz nedir? [*olmazsa olmaz*]

Böyle bir uygulamanın içeriğin hazır olarak verilmesi mi yoksa ihtiyaçlar doğrultusunda öğretmeni ya da ailesi tarafından belirlemesi mi daha uygun olur?

[Geçiş] Literatür ve piyasa araştırması yapılarak ilk prototipi hazırlanan uygulama alan uzmanına tanıtılacak

Yukarda verdiğiniz bilgiler ışığında bu uygulamayı nasıl değerlendirirsiniz?

Fikir

İçerik

Tasarım

Eklemek istedikleriniz

İletişim becerisi kazandırmak için böyle bir uygulamanın, hedef gruba nasıl bir yöntemle uygulanması daha uygun olur?

Sonuç

[Özet] Genel olarak neler üzerinde konuşulduysa özetlenecek

[Yakınlığı Sürdür] Teşekkür

[Bir Sonraki Adım] Gerekli bilgilerin hepsinin alındığı, katılımcıdan yeni bir bilgiye ihtiyaç duyulduğunda tekrar iletişime geçme isteği belirtilecek.

APPENDIX D

EXPERT REVIEW – I INTERVIEW PROTOCOL

Çalışma Başlığı	:	Otizmli bireylere iletişim becerisi kazandırmaya yönelik mobil uygulamaların kullanımının tasarım ilkeleri ile birlikte incelenmesi
Tarih / Saat	:	
Yer	:	
Görüşme Yapan Kişi	:	
Görüşülen Kişinin Pozisyonu	:	

Görüşme Planı		
Açılış		
Yakınlık Kurma	:	Merhabalar, adım Hamza. ODTU, Bilgisayar ve Öğretim Tek. Eğitimi Bölümünde, otizmli bireylerin ihtiyaçlarına uygun mobil uygulamalar üzerine çalışıyorum. Bu konuda sizden fikirleriniz bu bireylerin sorunlarını daha iyi anlama noktasında bize yardımcı olacak
Amaç	:	Görüşme süresince, özel eğitimdeki deneyiminiz ve bu alanla ilgi eğitim geçmişiniz çerçevesinde otizmli bireylerin günlük hayatta karşılaştığı bazı sorunlarla ilgili sorular yönelteceğim.
Motivasyon	:	Verdiğiniz bilgiler ışığında bu bireylerin sorunlarına yönelik mobil uygulama geliştireceğiz. Özel olarak, böyle bir uygulama akademik bakış açısıyla henüz Türkiye'de geliştirilmedi. Sizin yardımınızla, mobil uygulama şekillenecek ve belki de birçok otizmli bireyin günlük hayatta kullandığı vazgeçilmez bir araç olacak.

Zamanlama : Görüşmemiz tahminen 30-40 dakika civarında sürecektir.

Gelişme

[Konu] Eğitim Durumu ve Tecrübe

Lisans eğitiminizi hangi alanda tamamladınız?

Lisans eğitimi boyunca otizmli bireyleri yakından tanımanıza yardımcı olacak dersler aldınız mı?

Kaç yıldır özel eğitimde çalışıyorsunuz?

Bu süreç içerisinde otizmli bireylerle karşılaştınız mı?

[Konu] Otizmli Bireyler

Aldığınız eğitim ve tecrübelerinize dayanarak otizmi nasıl tanımlarsınız?

Sizce otizmli bireylerin temel özellikleri nelerdir?

[Konu] Mobil Uygulama Kullanılabilirlik

Sizce bu uygulama hedeflenen amaca uygun hazırlanmış mı?

Sizce bu uygulama hedeflenen kitlenin seviyesine uygun mu?

Uygulamanın içeriği beklentilerinizi karşıladı mı?

Uygulamada ek olarak görmek istediğiniz bir şeyler var mı? Varsa nelerdir.

Uygulamanın ara yüzü (görünümü) hakkında ne düşünüyorsunuz?

Hedef kitle ve amaç çerçevesinde renklerin kullanımı hakkında ne düşünüyorsunuz?

Uygulamada kullanılan metin bölümleri açıklayıcı mı?

Navigasyon sistemi hakkında ne düşünüyorsunuz? Sizce beklentiyi karşılar mı?

İlerde böyle bir uygulama kullanmak isterseniz, sizi bu uygulamayı kullanmaya iten ana sebep ne olurdu?

(Varsa) uygulamayla ilgili hoşunuza giden üç özellikten bahsedebilir misiniz?

(Varsa) uygulamayla ilgi hoşunuza gitmeyen üç özellikten bahsedebilir misiniz?

Uygulamayla ilgili bir şeyi değiştirmek isteseydiniz, ilk olarak neyin değişmesini istediniz?

Sonuç

[Özet] Genel olarak neler üzerinde konuşulduysa özetlenecek

[Yakınlığı Sürdür] Teşekkür

[Bir Sonraki Adım] Gerekli bilgilerin hepsinin alındığı, katılımcıdan yeni bir bilgiye ihtiyaç duyulduğunda tekrar iletişime geçme isteği belirtilecek.

APPENDIX E

EXPERT REVIEW II – SURVEY QUESTIONS

Değerli Katılımcı,

Bu çalışmanın amacı, otizmli bireylerin iletişim becerisi kazanabilmeleri için alternatif bir yol sunan mobil uygulama standartlarının belirlenmesidir. Bu kapsamda geliştirilen mobil uygulamanın kullanılabilirliğinin artırılabilmesi için siz değerli uzmanların görüşlerine ihtiyaç duymaktayız.

Uygulamayı geliştirirken, Bondy and Frost (1993) tarafından önerilen PECS'den (Picture Exchange Communication System) esinlendik, ve bu yöntemde yer alan araçları mobile aktarmaya çalıştık. Mobil uygulamayı yine PECS protokolleri çerçevesinde 6-8 yaşlarında otizmli bireylere uygulamayı planlıyoruz. Amacımız bu bireylerin geliştirdiğimiz uygulamayı kullanarak, kendilerini ifade edebilmelerine yardımcı olmak.

Uygulamayı özel eğitim öğretmenlerinin ve uzmanlarının görüşleri doğrultusunda mevcut haline getirdik. Bu aşamadan sonra tekrar siz değerli uzmanların görüşlerinize ihtiyacımız var. Sizlerden beklentimiz, aşağıdaki kriterleri göz önüne alarak mobil uygulamanın değerlendirilmesidir.

Zaman ayırdığınız için teşekkürler.

Mobil uygulamanın tanıtım videosu aşağıda verilmiştir.

Uygulama Tanıtım Linki: https://www.youtube.com/watch?v=VXYRidRjcu4

Çalışma hakkında daha fazla bilgi almak için Hamza Polat ile (polathamza87@gmail.com) iletişim kurabilirsiniz.

Demografik Bilgiler

Hangi bölüm mezunusunuz	:	
Eğitim Durumunuz	:	• Lisans • Yüksek lisans • Doktora
Özel eğitimdeki tecrübeniz	:	
Cinsiyet	:	○ Bayan ○ Erkek

Anket Soruları

1: Sizce bu uygulama hedeflenen amaca uygun hazırlanmış mı?

	1	2	3	4	5	
Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Mobil uygulamanın hedeflenen amaca daha uygun tasarlanabilmesi için varsa önerileriniz nelerdir.

2: Uygulama hedeflenen kitlenin (6-8 yaş otizmli bireyler) seviyesine uygun hazırlanmış.

	1	2	3	4	5	
Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Mobil uygulamanın hedeflenen kitlenin seviyesine uygun olarak tasarlanabilmesi için varsa önerileriniz nelerdir.

3: Uygulamanın içeriği beklentilerimi karşıladı.

1 2 3 4 5

Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Uygulamanın içeriğinin geliştirilebilmesi için varsa önerileriniz nelerdir.

4: Uygulamanın ara yüzü (görünümü) hedeflenen amaç doğrultusunda beklentilerimi karşıladı

	1	2	3	4	5	
Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Mobil uygulamanın ara yüzünü daha iyileştirebilmek için varsa önerileriniz nelerdir.

5: Hedef kitle ve amaç çerçevesinde renkler uygun olarak kullanılmış.

	1	2	3	4	5	
Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Renklerin kullanımıyla ilgili varsa önerileriniz nelerdir.

6: Uygulamada kullanılan metin bölümleri beklentilerimi karşıladı.

	1	2	3	4	5	
Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Mobil uygulamadaki metin bölümlerinin iyileştirilebilmesi için varsa önerileriniz nelerdir.

7: Navigasyon (Butonlarla yönlendirme işlemleri) sistemi beklentilerimi karşıladı.

	1	2	3	4	5	
Hiç Katılmıyorum	O	O	O	O	O	Kesinlikle Katılıyorum

Navigasyon sistemini iyileştirebilmemiz için varsa önerileriniz nelerdir.

Açık Uçlu Sorular

8: İlerde böyle bir uygulama kullanmak isterseniz, sizi bu uygulamayı kullanmaya iten ana sebep ne olurdu?

9: (Varsa) uygulamayla ilgili hoşunuza giden üç özellikten bahsedebilir misiniz?

10: Uygulamada ek olarak görmek istediğiniz bir şeyler var mı? Varsa nelerdir.

11: (Varsa) uygulamayla ilgi hoşunuza gitmeyen üç özellikten bahsedebilir misiniz?

12: (Varsa) Uygulamayla ilgili bir şeyi değiştirmek isteseydiniz, ilk olarak neyin değişmesini istediniz?

13: (Varsa) Genel olarak eklemek istedikleriniz.

APPENDIX F

CONSENT FORM FOR TEACHERS

Sayın Katılımcı,

Bu çalışmanın amacı, otizmli bireylerin iletişim becerilerini artırmak için alternatif bir yol sunan mobil uygulamaların standartlarının belirlenmesi ve bu standartlar çerçevesinde ilgili uygulamaların geliştirilerek test edilmesidir. Vereceğiniz bilgiler tamamen bu amaç doğrultusunda bilimsel çalışmalarda kullanılacaktır. Veri toplama esnasında sizden kimliğinizi açığa çıkartacak herhangi bir bilgi istenmeyecektir. Cevaplarınız gizli tutulacak ve araştırmacılar tarafından değerlendirilecektir.

Veri toplama esnasında sizi kişisel olarak rahatsız edecek sorular yöneltilmeyecektir. Görüşme, alandaki deneyiminize yönelik ve çalışmanın amacı doğrultusunda sorular içermektedir. Ancak katılım sırasında herhangi bir nedenden dolayı kendinizi rahatsız hissederseniz, çalışmaya daha sonra devam edebilir ya da çalışmadan tamamen ayrılabilirsiniz. Böyle bir durumu görüşme sırasında, ifade etmeniz yeterli olacaktır.

Bu çalışmaya tamamen gönüllü olarak katılıyorum ve istediğim zaman yarıda kesip çıkabileceğimi biliyorum. Verdiğim bilgilerin bilimsel amaçlı yayımlarda kullanılmasını kabul ediyorum.

Ad Soyad: **Tarih:** **İmza:**

Çalışmaya katıldığınız için şimdiden çok teşekkür ederiz. Çalışma hakkında ayrıntılı bilgi almak için ODTU, Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümünden, Arş. Gör. Hamza Polat ile iletişime geçebilirsiniz.

Oda: C 106

Mail: phamza@metu.edu.tr,

Tel: 0 (312) 210 7523

APPENDIX G

INFORMATION FORM AFTER THE PARTICIPATION

Değerli Katılımcı,

Bu çalışma, ODTÜ Bilgisayar ve Öğretim Teknolojileri Eğitimi bölümü doktora öğrencilerinden Hamza POLAT tarafından, otizmli bireylere iletişim becerisi kazandırmak ya da bu beceriyi artırmak için mobil uygulamaların geliştirilmesi ile birlikte değerlendirilmesi sürecini içermektedir. Bilindiği gibi otizmli bireylerin kendilerini ifade etmek gibi sosyal iletişim becerisi noktasından sorunlar yaşamaktalar. Bu problemlerin önüne geçmek için ise alternatif yöntemler kullanılmaktadır. Bu yöntemlerin bazısı özel araçlar gerektirirken, bazıları da herhangi bir ek araç gerektirmeden yapılmaktadır.

İletişim teknolojilerinde hızlı gelişmelerle birlikte, özel araç gerektiren iletişim yöntemleri de gelişti ve artık, söz konusu bireylerin daha hızlı uyum sağlayabileceği, toplam tarafından dışlanmalarını engelleyen ve de aileler tarafından kabul gören mobil teknolojiler iletişim becerisi kazandırılmak için kullanılmaya başlandı. Fakat burada üzerinde durulması gereken husus, bu teknolojilerin ihtiyaçlar doğrultusunda özelleştirilmesi ve hedef grubun kullanabileceği uygulamaları içermesidir. Bu bakımdan bu çalışmayla, günlük hayatta sıklıkla karşılaşılan bir probleme (otizmli bireylerin iletişim problemi), öğretim teknolojilerinin sunduğu öğretim tasarımı süreci ve özel eğitim de sıklıkla kullanılan davranış kuramları çerçevesinde çözüm üretilmeye çalışılacaktır.

Çalışma iki yönüyle mevcut çalışmalardan ayrılmaktadır. İlk olarak, özel eğitimde sıklıkla kullanılan ve literatürde Aided Alternative and Augmentative Communication olarak adlandırılan tablet uygulamaları, şimdiye kadar uygulamaların istenen beceri üzendeki etkisi çerçevesinde ele alınmıştır. Fakat bu uygulamalar içermesi gereken standartlarla birlikte geliştirilip test edilmemiştir. İkinci olarak da, Türkiye de adı geçen uygulamalar yok denecek kadar azdır. Yurt dışında geliştirilen uygulamalar ise Türkçe dilbilgisi yapı farklılığından dolayı Türkçeye çevrilip kullanılamamaktadır. Bu bakımdan hem Türkçe dil ve dilbilgisi desteği hem de problemin öğretim tasarımı süreci çerçevesinde analiz edilerek, uygun çözüm önerilerinin sunulması ve bunların hedeflenen grupta test edilmesi yönüyle öncü bir çalışma olması beklenmektedir.

Tasarım tabanlı araştırma yönteminin uygulanacağı bu çalışma, 2016 sonları ve 2017 yılı başlarında uygulanacaktır. Elde edilen bilgiler sadece bilimsel araştırma ve yazılarda kullanılacaktır. Çalışmanın sonuçlarını öğrenmek ya da bu araştırma hakkında daha fazla bilgi almak için aşağıdaki isimlere başvurabilirsiniz. Bu araştırmaya katıldığınız için tekrar çok teşekkür ederiz.

Doç. Dr. Ömer DELİALİOĞLU (Tel: 210 4198; E-posta: omerd@metu.edu.tr)

Arş. Gör. Hamza POLAT (Oda:C106; Tel: 210 7523; phamza@metu.edu.tr)

APPENDIX I

PARENT PERMISSION FORM FOR CHILDREN

Sayın Veli,

Bu çalışma Ortadoğu Teknik Üniversitesi öğretim üyesi Doç. Dr. Ömer DELİALİOĞLU danışmanlığında, doktora öğrencisi Hamza Polat tarafından yürütülmektedir.

Bu çalışmanın amacı: Otistik davranış bozukluğu (ASD) tanılı bireylerin sayısındaki hızlı artış, devletlerin ve kuruluşların bu kişilerin ihtiyaçlarına daha fazla yoğunlaşmasını beraberinde getirdi. Bununla birlikte, otizmli bireylere sosyal iletişim becerisi kazandırmayı amaçlayan alternatif iletişim (Alternative and Augmentative Communication:AAC) yöntemleri de yaygınlaştı. Ek bir donanım ya da araç gerektiren (aided) ve gerektirmeyen (unaided) olmak üzere ikiye ayrılan bu yöntemlerin literatürde birçok uygulaması mevcuttur. Bu çalışmanın amacı, otizmli bireyler için alternatif bir iletişim aracı olarak kullanılan mobil araçlarda çalışabilecek ve iletişim becerisi kazandırabilecek uygulamaların tasarım ilkeleriyle birlikte kullanımını incelemektir. Böylelikle, var olan bir probleme eğitim teknolojileri ve özel eğitim alanlarının imkanları çerçevesinde çözüm sunulmaya çalışılacaktır. Süreç sonunda bir adet tabletlerde çalışan mobil uygulama geliştirilmiş olacak ve bu uygulamanın otizmli bireylerin iletişim becerisine olan etkisi verilecektir.

Çalışma sırasında çocuğunuzdan **geliştirdiğimiz uygulama ile etkileşime geçmesini ve uygulamayı kullanarak isteklerini ifade etmesini** isteyeceğiz ve davranışlarını **görüntü kaydı** biçiminde toplayacağız. Sizden çocuğunuzun katılımcı olmasıyla ilgili izin istediğimiz gibi, çalışmaya başlamadan çocuğunuzdan da sözlü olarak katılımıyla ilgili rızası mutlaka alınacaktır.

Çocuğunuzdan alınan bilgiler ne amaçla ve nasıl kullanılacak? Çocuğunuzdan *davranışlarının gözlenmesiyle elde edilen kayıtlar tamamen gizli tutulacak ve sadece araştırmacılar tarafından değerlendirilecektir*. Elde edilecek bilgiler sadece **bilimsel amaçla** kullanılacak, çocuğunuzun ya da sizin isminiz ve kimlik bilgileriniz, hiçbir şekilde kimseyle paylaşılmayacaktır.

Çocuğunuz ya da siz çalışmayı yarıda kesmek isterseniz ne yapmalısınız? Katılım sırasında sorulan sorulardan ya da herhangi bir uygulama ile ilgili başka bir nedenden ötürü çocuğunuz kendisini rahatsız hissettiğini belirtirse, ya da kendi belirtmese de araştırmacı çocuğun rahatsız olduğunu öngörürse, çalışma tamamlanmadan son verilecektir. Şayet siz çocuğunuzun rahatsız olduğunu hissederseniz, böyle bir durumda çalışmadan sorumlu kişiye çocuğunuzun çalışmadan ayrılmasını istediğinizi söylemeniz yeterli olacaktır.

Bu araştırma ile ilgili herhangi bir sorunuz veya endişeniz varsa, lütfen araştırmacı ile iletişime geçiniz:

Orta Doğu Teknik Üniversitesi,

Bilgisayar ve Öğretim Teknolojileri Eğitimi Bölümü

Hamza POLAT, Oda: C 106 Mail: phamza@metu.edu.tr, Tel: 0 (312) 210 7523

Yukarıdaki bilgileri okudum ve velisi olduğum çocuğun bu çalışmada yer almasını onaylıyorum.

Çocuğun:	***Velinin:***
Ad Soyad:	***Ad Soyad:***
Doğum Tarihi:	***İmza:***

APPENDIX J

DEMOGRAPHIC INFORMATION FORM

DEMOGRAFİK BİLGİ FORMU					
Uygulama Başlama Tarihi	:		Uygulama Bitiş Tarihi	:	
Uygulama Sayısı	:				
Öğrenci Kodu:	:		Veli Kodu	:	
Öğretmen Kodu:	:				
Yaş:	:				
Okula Devam Süresi	:				
Yetersizlik Türü	:				
Yetersizlik Düzeyi (Özür oranı)	:				
IQ Seviyesi	:				
Ek Engel Durumu	:				

Çocuğun ailesiyle olan ilişkisi, onlarla oyun vb. oynuyor mu	:				
Çocuk iletişime meyil gösteriyor mu?	:				
Çocuk göz kontağı kuruyor mu?	:				
Anne Yaşı	:		Baba Yaşı	:	
Anne Eğitim Durumu	:		Baba Eğitim Durumu	:	
Anne Mesleği	:		Baba Mesleği	:	
Kardeş Sayısı	:				
Kardeş Yaşları	:				
Başka Kardeşte engel var mı	:				
Aile Gelir Durumu	:				
RAM'a geldiği günler	:				
Farklı bir yerden eğitim alıyor mu? Alıyorsa kurum adı ve sınıfı	:				

ÖN KOŞUL BECERİLER		
Ön Koşul Beceri	Yapabiliyor	Yapamıyor
Basit sözel yönergeleri takip edebilme (Birkaç kelimelik sözel yönergeleri yerine getirebilme)		

<table>
<tr><td colspan="3">Dikkatini maksimum 10 dakika bir etkinliğe verebilme</td><td></td><td></td></tr>
<tr><td colspan="3">Elini ve parmaklarını kullanabilme</td><td></td><td></td></tr>
<tr><td colspan="3">Sorulan soruya işaret ya da sözlü olarak tepki verebilme</td><td></td><td></td></tr>
<tr><td colspan="3">Öğretilmesi planlanan beceriyi yapamama</td><td></td><td></td></tr>
<tr><td>Not</td><td>:</td><td colspan="3"></td></tr>
<tr><th colspan="5">UYGULAMA ORTAMAI</th></tr>
<tr><td>Uygulama Ortamını Özellikleri</td><td>:</td><td colspan="3"></td></tr>
<tr><th colspan="5">UYGULAMA SONRASI</th></tr>
<tr><td>Uygulama Sonunda Öğrendiği Nesne Sayısı ve İsimleri</td><td>:</td><td colspan="3"></td></tr>
</table>

APPENDIX K

REINFORCEMENT FORM

İLETİŞİM NESNELERİ VE PEKİŞTİREÇ FORMU				
Öğrencinin Kodu				
Öğretmenin Kodu				
Öğrenci için tercih ettiğiniz pekiştireçleri işaretleyiniz (Öğretmenlerle görüşme sonucunda liste hazırlanmıştır)				
		Tür	Açıklama	Özel bir durum var mı alerji vb. gibi
		Kraker		
		Kek		
		Şeker		
		Kutu Süt		
		Bisküvi		
		Meyve Suyu		
		Çikolata		
		Cips		
		Sakız		
		Meye		

		Meyveli Yoğurt		
		Oyuncak		
Ailelerle görüşülecek ve ona göre yeni pekiştireçler eklenecek.				
		Tür	Açıklama	Özel bir durum var mı alerji vb. gibi

APPENDIX L

INTERVENTION AND FOLLOW-UP SESSIONS DATA COLLECTION FORM

<table>
<tr><td colspan="6">Değerli Uzman,

Otizmli Bireylere iletişim becerisi kazandırılabilmesi için, gerekli olan alt becerileri aşağıdaki kriterlere göre değerlendirmeniz beklenmektedir.

Katılımınız ve desteğiniz için teşekkürler.</td></tr>
<tr><td colspan="3">Öğrenci Kodu:</td><td colspan="3">Oturum Sayısı:</td></tr>
<tr><td colspan="3">Öğretmen Kodu:</td><td colspan="3">Başlangıç Zamanı:</td></tr>
<tr><td colspan="3">Tarih:</td><td colspan="3">Bitiş Zamanı:</td></tr>
<tr><td rowspan="7"><u>Görev 1:</u>

Fiziksel <u>yardımla</u> yakınında bulunan tableti kullanarak istediği nesneyi alır</td><td colspan="5">Önünde bulunan tableti isteğini ifade etmek için kullanır</td></tr>
<tr><td>No</td><td>Hedef Davranış</td><td>Doğru</td><td>Yanlış</td><td>Tepki yok</td></tr>
<tr><td>1</td><td>İletişimin kurulacağı kişinin karşısında masada oturabilir</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Önünde bulunan tabletteki resme tıklayarak istediği nesneyi alır.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Toplam</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Masa üzerinde farklı konumda ya da masanın yakınında bulunan tableti isteğini ifade etmek için kullanır</td></tr>
<tr><td>No</td><td>Hedef Davranış</td><td>Doğru</td><td>Yanlış</td><td>Tepki yok</td></tr>
</table>

<table>
<tr><td rowspan="3">(Tek Resimli)</td><td>1</td><td>İletişimin kurulacağı kişinin karşısında masada oturabilir</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Masanın üzerinde farklı bir yerde duran ya da masaya yakın bir yerde bulunan tabletteki resme tıklayarak istediği nesneyi alabilir.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Toplam</td><td></td><td></td><td></td></tr>
<tr><td rowspan="12"><u>Görev 2:</u>

EBA' yı <u>spontane</u> şekilde kullanarak istediği nesneyi alır.

(Tek Resimli)</td><td colspan="5">İletişim ortamının herhangi bir yerinde bulunan tableti, isteğini ifade etmek için kullanır</td></tr>
<tr><td>No</td><td>Hedef Davranış</td><td>Doğru</td><td>Yanlış</td><td>Tepki yok</td></tr>
<tr><td>1</td><td>Ortamda herhangi bir yerde bulunan tableti eline alabilir.</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Masada oturan iletişim ortağına yaklaşır.</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>Tabletteki resme tıklayarak istediği nesneyi alabilir.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Toplam</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">İletişim ortamının herhangi bir yerinde bulunan tableti, herhangi bir kişiye isteğini ifade etmek için kullanır.</td></tr>
<tr><td>No</td><td>Hedef Davranış</td><td>Doğru</td><td>Yanlış</td><td>Tepki yok</td></tr>
<tr><td>1</td><td>Ortamda herhangi bir yerde bulunan tableti eline alabilir.</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Masada oturan herhangi bir iletişim ortağına yaklaşır.</td><td></td><td></td><td></td></tr>
</table>

<table>
<tr><td rowspan="10"></td><td>3</td><td>Tabletteki resme tıklayarak istediği nesneyi alabilir.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Toplam</td><td></td><td></td><td></td></tr>
<tr><td colspan="5">Ortamda herhangi bir yerde bulunan farklı bir iletişim ortağına, isteğini ifade etmek için farklı bir yerde bulunan tableti kullanır.</td></tr>
<tr><td>No</td><td>Hedef Davranış</td><td>Doğru</td><td>Yanlış</td><td>Tepki yok</td></tr>
<tr><td>1</td><td>Ortamda herhangi bir yerde bulunan tableti eline alabilir.</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Ortamdaki farklı yerde duran herhangi bir iletişim ortağına yaklaşır.</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>Tabletteki resme tıklayarak istediği nesneyi alabilir.</td><td></td><td></td><td></td></tr>
<tr><td></td><td>Toplam</td><td></td><td></td><td></td></tr>
<tr><td rowspan="5"><u>Görev 3:</u>

EBA’ yı <u>Basit</u> ayırt etme yöntemiyle eşzamanlı olarak kullanır

(İki ya da daha fazla Resimli:
Resimlerin biri istenilen</td><td colspan="5">İletişim ortamının herhangi bir yerinde bulunan tableti, isteğini ifade etmek için kullanır</td></tr>
<tr><td>No</td><td>Hedef Davranış</td><td>Doğru</td><td>Yanlış</td><td>Tepki yok</td></tr>
<tr><td>1</td><td>Ortamda herhangi bir yerde bulunan tableti eline alabilir.</td><td></td><td></td><td></td></tr>
<tr><td>2</td><td>Ortamdaki farklı yerde duran iletişim ortağına yaklaşır.</td><td></td><td></td><td></td></tr>
<tr><td>3</td><td>Tabletteki iki resimden istediği nesnenin resmini ayırt eder ve bunu almak için resme tıklar.</td><td></td><td></td><td></td></tr>
</table>

nesneye ait, diğeri nötr ya da negatif uyarıcı)		(Resimlerden biri istenilen nesneye ait, diğeri nötr ya da negatif uyarıcı)			
		Toplam			
	İletişim ortamının herhangi bir yerinde bulunan tableti, herhangi bir kişiye isteğini ifade etmek için kullanır.				
	No	Hedef Davranış	Doğru	Yanlış	Tepki yok
	1	Ortamda herhangi bir yerde bulunan tableti eline alabilir.			
	2	Ortamdaki farklı yerde duran ***herhangi bir iletişim ortağına*** yaklaşır.			
	3	Tabletteki iki resimden istediği nesnenin resmini ayırt eder ve bunu almak için resme tıklar.			
		Toplam			
	Ortamda herhangi bir yerde bulunan farklı bir iletişim ortağına, isteğini ifade etmek için farklı bir yerde bulunan tableti kullanır.				
	No	Hedef Davranış	Doğru	Yanlış	Tepki yok
	1	Ortamda herhangi bir yerde bulunan tableti eline alabilir.			
	2	Ortamdaki farklı yerde duran herhangi bir iletişim ortağına yaklaşır.			

	3	Tabletteki ***üçten fazla resimden*** istediği nesnenin resmini ayırt eder ve bunu almak için resme tıklar.			
		Toplam			
Görev 4:	İletişim ortamının herhangi bir yerinde bulunan tableti, herhangi bir kişiye isteğini ifade etmek için kullanır.				
EBA' yı Şartlı ayırt etme yöntemiyle eşzamanlı olarak kullanır	No	Hedef Davranış	Doğru	Yanlış	Tepki yok
	1	Ortamda herhangi bir yerde bulunan tableti eline alabilir.			
	2	Ortamdaki farklı yerde duran herhangi bir iletişim ortağına yaklaşır.			
(İki ya da daha fazla Resimli: Resimlerin her biri istenilen bir nesneye ait)	3	Tabletteki ***iki resimden*** istediği nesnenin resmini ayırt eder ve bunu almak için resme tıklar. (Resimlerden her ikisi de istenilen objelere ait)			
		Toplam			
	İletişim ortamının herhangi bir yerinde bulunan tableti, herhangi bir kişiye isteğini ifade etmek için kullanır.				
	No	Hedef Davranış	Doğru	Yanlış	Tepki yok
	1	Ortamda herhangi bir yerde bulunan tableti eline alabilir.			

	2	Ortamdaki farklı yerde duran herhangi bir iletişim ortağına yaklaşır.			
	3	Tabletteki ***üçten fazla resimden*** istediği nesnenin resmini ayırt eder ve bunu almak için resme tıklar. (Resimlerin her birisi istenilen bir objelere ait)			
		Toplam			
<u>Görev 5:</u>	İletişim ortamının herhangi bir yerinde bulunan tableti, herhangi bir kişiye isteğini ifade etmek için kullanır.				
EBA' yı <u>Cümle Yapısına uygun şekilde</u> eşzamanlı olarak kullanır	No	Hedef Davranış	Doğru	Yanlış	Tepki yok
	1	Ortamda herhangi bir yerde bulunan tableti eline alabilir.			
	2	Ortamdaki farklı yerde duran herhangi bir iletişim ortağına yaklaşır.			
	3	İletişim ortağıyla göz kontağı kurar			
	4	Tabletteki ***cümle kur*** ikonuna tıklar			
	5	Tabletteki ***resimlerden*** istediği nesnenin resmini ayırt eder ve bunu almak için resme tıklar. (Resimlerden her birisi istenilen objelere ait)			
		Toplam			

APPENDIX M

INTERVENTION SESSION FIDELITY CHECKLIST FORM

Amaç: Bu form, otizmli bireylere iletişim becerisi kazandırmak için geliştirilen mobil yazılımın, uygulaması esnasında görev analizinde belirtilen planlamaya ne ölçüde tutarlılık gösterdiğini çıkarmak için hazırlanmıştır.

Yönerge: Bu formda, uygulama esnasında katılımcı tutumları ve ortam düzenlemesiyle ilgili bazı beklentiler listelenmiştir. Gözlemcinin, kamera kayıtlarını izleyerek bu beklentilerin yerine getirilip getirmediğini belirtmesi gerekmektedir. *Aşağıdaki listede yer alan beklentileri, uygulama esnasında karşılanmışsa "Evet", karşılanmamışsa "Hayır" olarak işaretleyiniz.*

Öğrenci Kodu:	**Tarih:**		
Gözlemci Kodu:	**Süre:**		
Oturum No:			
Görev 1: Fiziksel yardımla yakınında bulunan tableti kullanarak istediği nesneyi alır (Tek Resimli)			
No	Beklentiler	Evet	Hayır
1	Çocuk bir masaya oturtulur		
2	Çocuğun önüne ilgi çekici nesneler bırakılır		
3	Çocuğun belli bir süre bu nesnelerle ilgilenmesi sağlanır		
4	Çocuğa istediği nesneyi alabileceği söylenir		

5	(Varsa) Çocuğun ilgi duymadığı nesneler ortamdan uzaklaştırılır.		
6	Çocuğun tek bir nesneyi seçmesi beklenir.		
7	Objelerin yerleri değiştirilerek seçme işlemi yenilenir.		
8	Seçilen nesnenin tablete kaydı yapılır.		
9	Çocuğun karşısına masaya bir iletişim ortağı oturur.		
10	Tablet çocuğun önünde olacak şekilde masaya bırakılır		
11	Seçilen nesne iletişim ortağının önüne bırakılır.		
12	Çocuğun arkasına fiziksel ipucu verecek kişi geçer.		
13	Çocuk iletişim ortağının önündeki objeyi almaya çalıştığında, çocuğun arkasında bulunan yardımcı, çocuğun elini tutarak önündeki tablette yer alan resme dokunması sağlanır.		
14	Çocuk resme dokunur dokunmaz, iletişim ortağı önündeki nesneyi hemen çocuğa verir.		
15	İletişim ortağı istenilen nesneyi verirken, "Demek bunu (iletişim nesnesi) istiyorsun. Al bakalım… Aferin…" gibi sözel pekiştireç verir.		
16	Çocuk istediği nesneyi almak için, tabletteki resme dokunması gerektiğini öğrenene kadar, çocuğa fiziksel ipucu verilir.		
17	Zaman içerisinde fiziksel destek azaltılır, işaret ipucu verilir.		
18	Öğrenciden tepki gelmezse ya da öğrenciyi rahatsız edici bir durumla karşılaşılırsa çalışma sonlandırılır.		
Görev 2: EBA' yı spontane şekilde kullanarak istediği nesneyi alır. (Tek Resimli)			
No	Beklentiler	Evet	Hayır

1	Çocuğun önüne ilgi çekici nesneler bırakılır		
2	Çocuğun belli bir süre bu nesnelerle ilgilenmesi sağlanır		
3	Çocuğa istediği nesneyi alabileceği söylenir		
4	(Varsa) Çocuğun ilgi duymadığı nesneler ortamdan uzaklaştırılır.		
5	Çocuğun tek bir nesneyi seçmesi beklenir.		
6	Objelerin yerleri değiştirilerek seçme işlemi yenilenir.		
7	Seçilen nesnenin tablete kaydı yapılır.		
8	Uygulama esnasında tabletin odadaki yeri sürekli (çocuktan uzağa) değiştirilir.		
9	Uygulama esnasında iletişim ortağı odada farklı yerlerde (çocuktan uzakta) bulunur.		
10	İstenilen obje, iletişim ortağının elinde ya da yakınında bulunur.		
11	Çocuğun tableti alarak, iletişim ortağının yanına getirmesi için (gerekirse) fiziksel ipucu verilir.		
12	Çocuk tableti alıp, iletişim ortağının yanına gelip, istenilen nesnenin resmine dokunursa, obje çocuğa hemen verilir.		
13	İletişim ortağı istenilen nesneyi verirken, "Demek bunu (iletişim nesnesi) istiyorsun. Al bakalım… Aferin…" gibi sözel pekiştireç verir.		
14	Farklı iletişim ortaklarıyla uygulama yapılır.		
15	Çocuk istediği nesneyi almak için, tableti alarak iletişim ortağına yaklaşıp, nesnenin resmine dokunması gerektiğini öğrenene kadar, çocuğa fiziksel ipucu verilir.		
16	Uygulama esnasında, iletişim ortağı veya yardımcı herhangi bir sözel ipucu kullanmaz (Buraya bas, vb.).		

17	Öğrenciden tepki gelmezse ya da öğrenciyi rahatsız edici bir durumla karşılaşılırsa çalışma sonlandırılır.		
<u>Görev 3:</u> EBA' yı <u>Basit</u> ayırt etme yöntemiyle eşzamanlı olarak kullanır (İki ya da daha fazla Resimli: Resimlerin biri istenilen nesneye ait, diğeri nötr ya da negatif uyarıcı)			
No	Beklentiler	Evet	Hayır
1	Seçilen nesnenin tablete kaydı yapılır.		
2	Tablete çocuk için nötr ya da tercih edilmeyen yeni nesne resmi/resimleri eklenir.		
3	İstenilen obje, iletişim ortağının elinde ya da yakınında bulunur.		
4	Çocuğun tableti alarak, iletişim ortağının yanına getirmesi için (gerekirse) fiziksel ipucu verilir.		
5	Çocuk tableti alıp, iletişim ortağının yanına gelip, istenilen nesnenin resmine dokunursa, obje çocuğa hemen verilir.		
6	İletişim ortağı istenilen nesneyi verirken, "Demek bunu (iletişim nesnesi) istiyorsun. Al bakalım… Aferin…" gibi sözel pekiştireç verir.		
7	(Varsa) Çocuk iki resimden tercih edilen nesnenin resmini ayırt etmekte zorlanırsa, tercih edilmeyen ya da nötr resmin alfa değeri (görünürlüğü) azaltılır.		
8	Eğer çocuk nötr ya da tercih edilmeyen nesnenin resmine dokunursa, iletişim ortağı, "Bundan (nesne) yoktur ki bende…" diye sözel tepki verir.		
9	Farklı iletişim ortaklarıyla uygulama yapılır.		

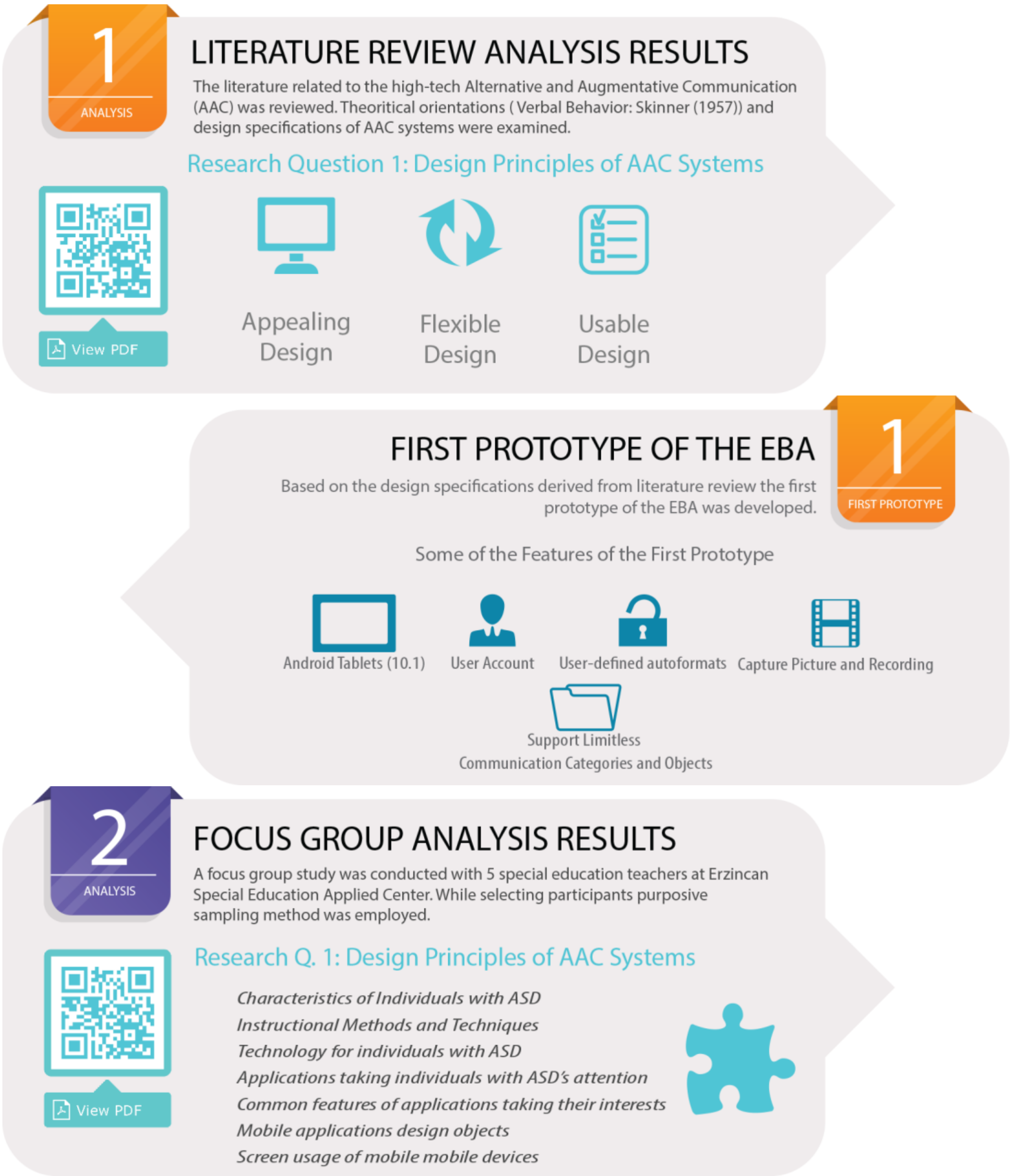
10	Uygulama esnasında, iletişim ortağı veya yardımcı herhangi bir sözel ipucu kullanmaz (Buraya bas, vb.).		
11	Öğrenciden tepki gelmezse ya da öğrenciyi rahatsız edici bir durumla karşılaşılırsa çalışma sonlandırılır.		
Görev 4: EBA' yı Şartlı ayırt etme yöntemiyle eşzamanlı olarak kullanır (İki ya da daha fazla Resimli: Resimlerin her biri istenilen bir nesneye ait)			
No	Beklentiler	Evet	Hayır
1	Seçilen nesnenin tablete kaydı yapılır.		
2	Tablete çocuk için tercih edilen yeni nesne resmi/resimleri eklenir.		
3	İstenilen obje, iletişim ortağının elinde ya da yakınında bulunur.		
4	Çocuğun tableti alarak, iletişim ortağının yanına getirmesi için (gerekirse) fiziksel ipucu verilir.		
5	Çocuk tableti alıp, iletişim ortağının yanına gelip, istenilen nesnenin resmine dokunursa, nesne çocuğa hemen verilir.		
6	İletişim ortağı istenilen nesneyi verirken, "Demek bunu (iletişim nesnesi) istiyorsun. Al bakalım… Aferin…" gibi sözel pekiştireç verir.		
7	Çocuğun resimlerle, bu resimlere karşılık gelen nesneleri eşleştirdiğini kontrol etmek için, iletişim ortağı herhangi bir nesneyi çocuğa uzatır.		
8	Çocuk uzatılan nesneye karşılık gelen resmi ayırt etmekte zorlanırsa, önce işaret ipucu, yine zorlanırsa fiziksel ipucu verilir.		

9	Uygulama esnasında, iletişim ortağı veya yardımcı herhangi bir sözel ipucu kullanmaz (Buraya bas, vb.).		
10	Öğrenciden tepki gelmezse ya da öğrenciyi rahatsız edici bir durumla karşılaşılırsa çalışma sonlandırılır.		
Görev 5: EBA' yı Cümle Yapısına uygun şekilde eşzamanlı olarak kullanır			
No	Beklentiler	Evet	Hayır
1	Çocuk bir masaya oturtulur		
2	Çocuğun karşısına iletişim ortağı geçer		
3	Çocuğun arkasına fiziksel destek verecek yardımcı geçer		
4	Tablet çocuğun önüne bırakılır		
5	Tercih edilen nesneyi iletişim ortağı elinde ya da yakınında bulundurur.		
6	Çocuk, tercih edilen nesneyi almaya çalıştığında, arkasında bulunan yardımcı fiziksel ipucu kullanarak, "cümle kur" butonuna çocuğun dokunmasını sağlar.		
7	Çocuk cümle kur, kısmından istediği nesnenin resmine dokunduğunda, iletişim ortağı nesneyi çocuğa hemen verilir.		
8	İletişim ortağı istenilen nesneyi verirken, "Demek bunu (iletişim nesnesi) istiyorsun. Al bakalım… Aferin…" gibi sözel pekiştireç verir.		
9	Uygulama esnasında, iletişim ortağı veya yardımcı herhangi bir sözel ipucu kullanmaz (Buraya bas, vb.).		
10	Öğrenciden tepki gelmezse ya da öğrenciyi rahatsız edici bir durumla karşılaşılırsa çalışma sonlandırılır.		

APPENDIX N

RESEARCH CYCLES AND ITERATIONS

RESEARCH CYCLES **ITERATIONS**



FIRST ITERATION: INITIAL DESIGN PRINCIPLES & SECOND PROTOTYPE

2
FIRST ITERATION

After the focus group study, the initial design specifications was provided and based on these specifications the second prototype was released.

Second Prototype

Functional navigation *
Settings to increase autonomy *
Template customazation *
Log tarcking system *
Ability to update voice records *

The design specifications were grouped under the titles

* Characteristics of individuals with ASD
* Screen Usage
* Features having influence on their interests

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EXPERT REVIEW I ANALYSIS RESULTS

3
DESIGN & DEVELOP.

An expert review was conducted with a special education teacher to make the formative evaluation of the developed AAC application. Since the participants did not have chance to experience with the EBA during the focus group, in this phase the participant first used the EBA, and then an in-depth interview was condedcted. The interview results included suggestions related to the following topics.

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Research Q. 1: Design Principles of AAC Systems

Appropriateness of the EBA for the target purpose and group
Whether the EBA meets the expectations of practitioners or not
New features that could be added to EBA
Formative evaluation of the user interface
Use of colors and informative texts
Navigation system
Pros and cons of the EBA

SECOND ITERATION: REFINEMENTS ON DESIGN PRINCIPLES & THIRD PROTOTYPE

3
SECOND ITERATION

After the first expert review analysis, the initial design principles were revised and based on these refinements the third prototype of the EBA was

Third Prototype

Optional parent control service added to the system *
Help documents were embeded to the EBA *

New design specifications

* The application should be designed in a way that prevents children from obsessive behaviors.
* The application should include help documentation to guide practitioners for accurate implementation

EXPERT REVIEW II ANALYSIS RESULTS

4
DESIGN & DEVELOP.

The proposed AAC application was evaluated by a group of academicians in the field by using an online survey including both likert type and open-ended questions to reveal the ultimate design specifications of high-tech AAC systems.

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Research Q. 1: Design Principles of AAC Systems

4.36

The Overall Satisfaction Mean Score

Suggestions to make EBA more usable
Ebaloration of EBA with regard to positive and negative aspects

4
THIRD ITERATION

THIRD ITERATION: REFINEMENTS ON DESIGN PRINCIPLES & THIRD PROTOTYPE

After the second expert review analysis, the previous design principles were revised and based on these refinements the ultimate prototype of the EBA was developed.

Ultimate Prototype	New design specifications
Object sizes and positions on the can be changed according to individual differences. *	* Object icons on the screen should be resized and repositioned by the users.
The time interval between sentence component was reduced while the device generating voice. *	* Sounds should be generated as natural as possible.
An option was added to omit the subject of the sentence in sentence form. *	

5
EVALUATION

SINGLE SUBJECT CASE STUDY

The ultimate prototype of the EBA was tested in the field by following an instructional strategy similar to the PECS protocols with three children with ASD to understand how they initiate functional communication including simple and multi-step requesting.

Research Q. 2 & 2a: Functional Communication & Requesting

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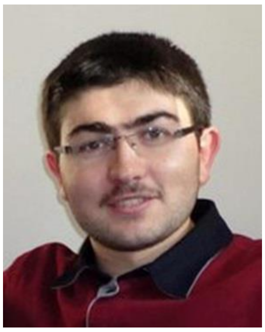
Participant 1	*Participant 2*	*Participant 3*
FC: 92.5 %	*FC: 73.7 %*	*FC: 92.5 %*
R: .98	*R: 1.00*	*R: .96*

FC: The persentage of functional communication total correct response,
R: The total mean score of requesting act

CURRICULUM VITAE

PERSONAL INFORMATION



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EDUCATION

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WORK EXPERIENCE

Year	**Place**	**Enrollment**
2016-Present	Erzincan Binali Yıldırım University	Research Assistant
2012-2016	Middle East Technical University	Research Assistant
2012	Erzincan University	Research Assistant
2010- 2011	Ministry of Education	Project Coordinator

FOREIGN LANGUAGES

Advanced English

PUBLICATIONS

Polat H., Öz R., "Use of the Distributed Cognition Theory in a Lesson Plan: A Theory, a Model and a Lesson Plan", Erzincan Üniversitesi Eğitim Fakültesi Dergisi, vol.19, pp.180-190, 2017

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HOBBIES

Tracking, Computer Technologies, Multimedia Design