DOKUZ EYLÜL UNIVERSITY
GRADUATE SCHOOL OF NATURAL AND APPLIED SCIENCES

COMPUTER AIDED LIP READING TRAINING TOOL

by

Gamze SARMAŞIK

October, 2009

İZMİR

COMPUTER AIDED LIP READING TRAINING TOOL

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Graduate School of Natural and Applied Sciences of Dokuz Eylül University
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in Computer Engineering

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Gamze SARMAŞIK

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Ph.D. THESIS EXAMINATION RESULT FORM

We have read the thesis entitled **"COMPUTER AIDED LIPREADING TOOL"** completed by **GAMZE SARMAŞIK** under supervision of **PROF. DR. ALP KUT** and we certify that in our opinion it is fully adequate, in scope and in quality, as a thesis for the degree of Doctor of Philosophy.

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ABSTRACT

Worldwide oral language education is becoming widespread for hearing impaired children. Nowadays hearing loss in babies can be diagnosed with newborn hearing screening tests and cochlear implantation can be performed when required. Implanted children can not start to hear and talk all by themselves as it is in normal hearing children. After implantation, every child should receive adequate speech training sessions. But, this special supplemental education is tiring work for both children and educator. A computer aided instructional tool may help to lessen the hardship and struggle that children and educators experience during the educational sessions.

In these respect, AURIS is designed as a computer aided instructional tool combining both visual and audio technology for assisting teachers of hearing impaired in their practice. AURIS is developed to improve verbal communication skills of hearing impaired children. AURIS stands on residual hearing of hearing impaired children. It is necessary to emphasize that AURIS which is introduced in this thesis is only a prototype.

Additionally, the result of the effectiveness of the AURIS which has been tested on preschool hearing impaired children (ages 2-6) as a case study, is presented in this thesis. These results show that using AURIS in hearing impaired education, children can learn concepts and nouns quickly and easily with the help of moving images and visual effects. At the end of the sessions, it is observed that children could even comprehend three word sentences and improve their speaking and pronunciation skills with the help of voice analysis methods inserted in AURIS.

Keywords: Computer aided instruction, Computer aided education tool, Educational software, Hearing impairment, Hearing loss, Hearing impaired children, Preschool deaf children, Language acquisition

BİLGİSAYAR DESTEKLİ DUDAK OKUMA EĞİTİM ARACI

ÖZ

Tüm dünyada işitme engelliler için sözel dil eğitimi yaygınlaşmaktadır. Günümüzde, işitme engeli bebeklerde, yeni doğan işitme tarama testleri ile saptanabilmekte ve gereksinime göre yapay kulak ameliyatı yapılmaktadır. Yapay kulak ameliyatı olmuş çocuklar, normal yaşıtları gibi kendi başlarına duyup, konuşmaya başlamazlar. Ameliyattan sonra her çocuk uygun konuşma eğitimi almalıdır. Fakat bu özel destekli eğitim hem çocuk hem de eğitimci için çok yorucudur. Bilgisayar tabanlı bir eğitim aracı, eğitimci ve çocuğun eğitim uygulamaları sırasında karşılaştığı zorluk ve sıkıntıyı azaltmaya yarayabilir.

Bu bilgiler doğrultusunda, AURIS, işitme engelliler eğitimcisine yol göstermek üzere, görsel ve işitsel teknolojiyi içeren bir bilgisayar tabanlı bir eğitim aracı olarak tasarlanmıştır. AURIS, işitme engelli çocuğun sözel iletişimini geliştirmek üzere geliştirilmiştir. AURIS, işitme engelli çocuğun işitme kalınsı üzerine dayanır. Bu tezde tanıtılan AURIS'in yalnızca bir prototip olduğunu belirtmemiz gerekmektedir.

Ayrıca, bu tezde, AURIS'in, işitme engelli (yaşları 2-6) olan çocuklar ile etkinliğinin test edildiği uygulama sonuçları sunulmuştur. Bu sonuçlar, işitme engelliler eğitiminde, AURIS'i kullanmanın, çocukların kavramları ve kelimeleri çok çabuk ve kolayca öğrenmelerinde yardımcı olduğunu göstermektedir. Hatta son uygulamalarda, çocukların üç sözcüklü tümceler kurabildikleri ve ses analiz modülü ile konuşma ve telaffuz yeteneklerini geliştirdikleri gözlemlenmiştir.

Anahtar Sözcükler: Bilgisayar tabanlı öğretim, Bilgisayar tabanlı eğitim aracı, Eğitim yazılımı, İşitme kaybı, İşitme engelli çocuklar, Okulöncesi işitme engelli çocuklar, Dil öğrenimi

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CHAPTER ONE
INTRODUCTION

1.1 Background of the Motivation

For the first time, some arguments for the education of the hearing impaired children were put forth in 1500s, yet, no systematic training program for the deaf was developed until 1700s. Although some training attempts were seen in the different countries of Europe, in 18th century as sign language or oral method, unfortunately, throughout the history, till 20th century, in all the world, the hearing impaired were excluded from the society, isolated and devoid of many human rights, and they were even considered mentally ill. Most of them managed to survive by begging and lived in poverty (Selvi, 2004).

With the technological developments in hearing aids in 20th century, there was a shift from the sign language to verbal communication in the education of the hearing impaired children. The hearing impaired started to be educated in deaf schools designed for hearing impaired. Today, with the success obtained from the cochlear implant operations, and with the support of orientation programmes and special education systems, the hearing impaired can be integrated to mainstream school environment together with normal hearing peers instead of deaf schools and they can continue their academic education. Due to these developments, today, hearing impairment is not a factor isolating hearing impaired from the society because through early diagnosis and technological advancements, they can lead a life similar to a healthy individual.

In spite of all these positive developments, it is not possible for the hearing impaired to naturally start hearing and talking like healthy children. For them, verbal communication training is hard, demanding and challenging process requiring continuity. Moreover, the success level of the education varies depending on the personal characteristics, the extent of the loss of the sense of hearing, intelligence, time of diagnosis, educational settings and the family support.

Even early identified hearing impaired children, exhibit delayed acquisition of receptive and expressive language skills and perform at significantly lower levels on the majority of the cognitive tasks (Vohr & etc, 2008; Lyxell & etc, 2008). A healthy baby starts hearing the sounds in her/his mother's womb at 5 months. But for hearing impaired baby, since there is no sound transmitted to the brain, the section of the brain as reserved for hearing is reserving for another function. After implanted, sound stimuli are transmitted to the brain and a section for hearing ought to be opened in the brain. When the children 2-3 years old, it is evident that the hearing impaired children are at least two years behind of normally hearing peers, for language learning. So the oral education of preschool hearing impaired children is a very complicated process. Because in this period, a hearing impaired child does not know yet that everything has a name which describing by sound. The education of the hearing impaired to be provided for the preschool children shall be a study that would be fulfilled together with teaching concept, language acquisition, lipreading and auditory therapy which begins with perceiving sounds. And this process should be also handled together by considering their mental development process compared to their peers. During the education of the hearing impaired children, absence of fifth sense of hearing has to be complemented through strengthening with other four senses, particularly the sense of seeing. They hear by seeing.

When the hearing impaired children continue their education and daily lives, they may start to make use of the computer. Because, today, in every stage of education, the computer started to take its place, from kindergarten to university. Moreover, computers have become integrated in every aspect of our lives. It is very important for the hearing impaired children to start computer aided education in their preschool education, so that they can adapt themselves to the technology era and society in which they are living and will live in. In primary school, when the hearing impaired have learned reading-writing, they will be able to use the computer as easily as healthy individuals do. Because visual elements can easily be displayed and emphasized in computers; thus, the hearing impaired can perceive information due to their developed sense of seeing. They should meet computers as early as possible, not to be externalized from the society as earlier centuries. Hence, in this thesis, it is

proposed that there is an urgent need for educational software to support the language education of the hearing impaired. Unfortunately, nowadays, computer aided educational tools for hearing impaired children are in the preliminary stage yet.

1.2 The Aim of Thesis

In recent years, there are few some computer aided instructional tools which have been developed for the education of the hearing impaired. However, since these tools have been developed with commercial concern, they have not resulted in the desired success and accordingly be common place. Because the computer aided instructional tool developed for the hearing impaired children require cooperation among different disciplines such as medicine, engineering, education, psychoacoustics, linguistics, psychology, special education, preschool education, and speech therapy. These have to be also handled unbiased, non-profit, self denying and as a scientific study.

The topic of this thesis, AURIS computer aided tool, developed to support the acquisition of the verbal language of hearing impaired preschool children who are in the process of speech acquisition. Therefore, AURIS designed not only for the hearing impaired children's development of perceiving the phonemes, and also for teaching concept while learning structures of language by lipreading and speechreading. In addition, while taking attention to what is told, encouraging them to talk as natural language environment, and in advance perceiving to recognize their mistakes in their pronunciation as visually and teaching how to make necessary corrections.

The thesis point of view:

- Enriching an education process which is demanding and tiring for both children and educators by means of computers and computer programs and making it easier and more enjoyable.
- Determining the difficulties encountered by the hearing impaired during the education process, and making use of the computer to overcome these difficulties and make learning environment more enjoyful and efficient.

- Making it possible for the hearing impaired education to be standardized and widespread by applying computer aided instructional program for the education of the hearing impaired.
- Announcing the success of the tool used, so that other educators and families can become aware of it and motivated to draw on it for their students and children.
- Shedding some light on the developments of the world of hearing impaired people.
- Making some contributions to the current literature by reviewing the work done so far and in this way, determining the shortcomings and requirements of the field and making suggestions in light of these findings.

The main purpose of this thesis is to develop an instructional computer aided tool based on scientific foundations to meet the needs of the hearing impaired. In this thesis, it is aimed to make some contributions to the world of the disabled children with the help of our background knowledge in the field of computer engineering.

1.3 Thesis Organization

In the second chapter of this thesis, the educational methodologies for the hearing impaired preschool children are investigated. At the beginning of the chapter, the hearing impairment is defined and then hearing impaired children's needs regarding the oral education is determined.

In the third chapter, literature review is performed about the computer aided instructional tools used for language learning, lip reading, articulation disorders and the effectiveness of computer based environment for preschool children and disabled children.

Chapter four focuses on the components of oral education methodology and the role of lipreading. In this chapter, how this theory could be integrated to the software and AURIS's software specification is presented.

In the last Chapter, the application of AURIS is summarized as a case study, results and the effectiveness of AURIS is evaluated as a computer based instruction tool in early literacy acquisition of hearing impaired preschool children.

CHAPTER TWO
EDUCATIONAL METHODOLOGY IN CHILDHOOD HEARING IMPAIRMENT

2.1 Definition of Hearing Impairment

Hearing Impairment is a full or partial loss of the ability to detect sounds. The inability to hear sounds, or distinguish among different sounds, especially in babies and small children, will result in problems with speech and language development. 'Deafness' is the traditional term used to describe profound hearing loss, but 'hearing impairment' is the preferred term that encompasses the fact there are different degrees of hearing losses (Morse, 2006).

2.2 Identification of Hearing Loss

Hearing loss in babies can be early diagnosed by hearing screening tests, to be accomplished before 6 months of age. The main aim of the national screening program in Turkey, which began in year 2004, is to fit infants with hearing aids or cochlear implants before 6 months.

2.2.1 Types of Deafness

There are mainly four different types of hearing losses that a child can have (Zapien, 1998):

- **Conductive Loss:** Conductive losses are caused by blockage or disease of the outer or middle ear. Threholds are generally less than 60 deciBels (dB). Conductive hearing losses are generally treatable by a physician and account for 5 to 10% of all hearing losses (Zapien, 1998). Conductive hearing losses usually involve a reduction in sound level, or the ability to hear faint sounds. This type of hearing loss can often be medically or surgically corrected (Clark, 1981).

- **Sensorineural Hearing Loss:** Sensorineural hearing loss occurs when there is damage to the inner ear (i.e. cochlear pathologies) or to the nerve pathways from the inner ear to the brain (i.e. retrocochlear pathologies). Usually sensorineural hearing losses cannot be medically or surgically corrected. It is considered as a permanent loss. Sensorineural hearing losses not only involve a reduction in sound level, or ability to hear faint sounds, but also affect speech understanding, or ability to hear clearly (Clark, 1981). Sensorineural hearing losses affect both loudness and fidelity of perceived sound (Freeman, Carbin, & Boese, 1981). The hearing loss due to aging mainly affects perception of the high tones. This is important because consonant sounds are high tones. These sounds help discriminate one word from another. In these cases, amplification may not always helpful because the distortion is amplified as well as the speech sounds (Zapien, 1998). Sensorineural hearing loss can be caused by diseases, birth injury, drugs that are toxic to the auditory system, and genetic syndromes. Sensorineural hearing loss may also occur as a result of noise exposure, viruses, head trauma, aging, and tumors (Clark, 1981).

- **Mixed Loss:** It is a mixture of both sensorineural and conductive losses. Mixed losses cause difficulty with both distortion and loudness. As conductive losses tend to fluctuate, depending on the nature of the loss, mixed losses may also fluctuate (Zapien, 1998).

- **Central Hearing Loss:** Central hearing loss involves the auditory centers in the brain. This kind of loss involves the brain-end of the process rather than the hearing end (Marschak, 1997).

2.2.2 Classification Related To Onset of Hearing Loss

Another consideration in determining the type of education a child should receive is the time of onset of hearing impairment. If a child has never had the opportunity

to learn his parent's native language, then she/he is in a different position than the child who has already acquired the language.

- **Prelingual Hearing impairment**

  Prelingual hearing impairment can be defined as deafness that occurs before the child has the opportunity to learn and begin speaking his parents' native language.

- **Perilingual Hearing impairment**

  If hearing loss occurs while the native language learning process takes place, it is called perilingual hearing loss.

- **Postlingual Hearing impairment**

  Postlingual hearing impairment can be defined as deafness that occurs after the child has learned the parents' native spoken language. The educational needs of the child deafened postlingually differently than the child born deaf. While postlingually hearing impaired child may remember the speech sounds, the other child may not. While postlingually hearing impaired child has already learned parents' native tongue and has unlocked the rules to reading, the other child does not have this benefit.

2.3 Methods for Hearing Impairment Instruction

To choose an appropriate education methodology for the hearing impaired children, the type of hearing loss has to be determined first. Method for hearing impaired are:

I. Sign Language
II. Auditory

a. Auditory / Oral
b. Auditory / Verbal
c. Cued Speech

III. Bilingual
IV. Total Communication

2.3.1 Sign Language

Its purpose is to present spoken language visually. "Sign codes have been designed to convey, insofar as possible, the detailed structure and grammar of the spoken language. (Freeman, Carbin, & Boese, 1981)" The end goal of using these systems is based on the rules of English language and English literacy. The rules are different from code to code. They all use English word order and they are signed while speaking simultaneously (Zapien, 1998). There is hardly any conventional sign language established in Turkey.

2.3.2 Auditory

The oral programs have an emphasis on spoken language and listening. In this technique, no sign language is employed (Orsi, 2005). The goal of the auditory methods is to teach a child how to use his residual hearing so that he may have access to spoken language. "Most deaf children have some residual (remaining) hearing. The brain, which develops rapidly in the first few years of life, needs rich language input during that time (Freeman, Carbin, & Boese, 1981)". "The speech signal is redundant. Since it carries excess information, it is not necessary to hear every sound to understand a message. (National Information Center on Deafness, 1989)" Additionally, there is also a great emphasis on speech and speechreading. The ultimate educational goal is to place the child in a mainstream school environment (Zapien, 1998). Three variations of the oral approach are described below (Orsi, 2005; Zapien, 1998; Canalis & Lambert, 2000).

2.3.2.1 Auditory / Oral

Also known as **"**The multisensory method**" "**look and listen**" "**auditory global**".** This method requires children to use their residual hearing in combination with speech reading (previously called lipreading) to understand speech. Children learn to listen and lipread; additionally natural gestures are accepted. In this method, teachers encourage the development of oral language through listening, lipreading, kinesthetic and tactile cues, such as placing the child's hand on the teacher's face and neck (Canalis & Lambert, 2000).

2.3.2.2 Auditory / Verbal

In this method, children, usually have at least some residual hearing (but it is not an absolute requirement) and can make use of hearing aids or cochlear implant. In this intensive therapy, children's listening skills (instructor covers their lip movements) are improved and language is build through listening. No sign language is used (Orsi, 2005).

Auditory / verbal proponents encourage a dependence on listening by often depriving the child of speechreading cues, hoping to allow the child to use his or her aided hearing to its full potential (Canalis, Lambert, 2000). This therapy is not widely available. This therapy for only for children that are aided earlier (Zapien, 1998).

2.3.2.3 Cued Speech

It can be defined as a visual picture of the speech sounds and sound patterns that are used in the English language or any of the other 50 languages and dialects for which cueing has been adapted. Dr. Orin Cornett invented Cued Speech in 1966 at Gallaudet University. In American English, this system uses eight different handshapes in four different locations near the mouth. The shapes and

locations in combination with the mouth movements eliminate the ambiguity of speechreading (Zapien, 1998).

This method, different from sign language, clarifies the sounds using handshapes to identify sounds (Example: difference between "bat" and "pat"). Cued Speech is not a widely used method (Orsi, 2005).

2.3.3 Bilingual

The bilingual/bicultural philosophy recognizes Sign Language as the primary language of the hearing impaired child and uses for instruction and conceptual understanding of material. In addition, teachers teach oral language as a second language for reading and writing. The child is considered "bilingual" when they have mastered both languages (Orsi, 2005).

2.3.4 Total Communication

Total Communication can best be defined as eclectic, borrowing techniques from a variety of methods. Ideally teachers can use sign, writing, mime, speech, pictures or any other communication method that works. The method of communication should depend upon the needs of the student and the situation. In actual practice, most Total Communication programs use some form of Simultaneous Communication. Children are encouraged to work on speech and listening skills. "All children are encouraged to develop skills in variety of areas (sign language, speech and audition), although children are allowed to develop a mode of communication that is best for them (Zapien, 1998)".

2.4 Advantages and Disadvantages of Hearing Impaired Instruction Methods

Experts' comments from a different point of view about advantages and disadvantages of methods could be summarized as follows:

2.4.1 Advantages and Disadvantages of Sign Language

There are several disadvantages of Sign Language that should not be brushed aside or ignored (Zapien, 1998):

- Ninety percent of deaf children are born to hearing parents. The vast majority of these parents are not native signers. Signing is a difficult skill for hearing parents to master and they may resent having a stranger in their home. Normal hearing parents if they are not using sign language with each other could not be a model for their child.
- Sign Language approach is not a common communication method. Only a very few people know sign language in the society. So hearing impaired people who use only sign language will be outside of the society as a externalized minority.
- Sign Language has a very limited terminology when it is compared to oral language.
- Originally sign language is constructed according to English Grammar system. This technique may not be sufficient for Turkish speaking environments.
- Sign Language includes regional differences. Even signer who graduated from different schools in Turkey may differ from each other.

2.4.2 Advantages and Disadvantages of Bilingual Method

Deaf child might acquire sign language as a primary language, then he/she may learn oral language as a second language. If a child learns first sign language, this restricts his/her verbal development. A child with bilingual language may not spend time working on audition or speech. In fact, “it is felt to be morally wrong to impose on deaf children a language they cannot acquire, this, spoken language (Zapien, 1998). This policy can limit participation in hearing culture.

2.4.3 Advantages and Disadvantages of Total Communication Method

In total communication method, instructor uses a combination of various methods and approaches to meet the individual child's needs. Besides the disadvantages associated with total communication method, it tends to limit a child's language experience. Children are never exposed to complex oral language or complex sign language (Zapien, 1998). There is no standard education that can be generalized for classroom environment in this method (Ministry of Education [M.E.B.], 2003).

2.4.4 Advantages and Disadvantages of Auditory Method

The goal of the auditory methods is to teach a child how to use his residual hearing so that he/she may have access to spoken language.

In this century, suggested education method tends to be auditory method, because of the success of the cochlear implantation in the process of improving verbal communication skills. Not only instructors but also families and the children itself prefer auditory method. A parent respondent shared this insight "No one has one right way to raise a deaf child, any more than anyone has one right way to raise a hearing child (Schein & Stewart, 1995)".

2.5 Historical Development of Methods

Education for hearing impaired first started in Italy, by an Italian Physician, Geramino Carnado, in 1500s. He found that the hearing impaired could be educated by using the written word. In the same time in Spain, a monk Juan Pablo de Bonet, used the earliest reading, writing and speechreading as well as his own manual alphabet to educate the hearing impaired. This was the first known manual alphabet system in the history of sign language. The handshapes in this alphabet represented the different speech sounds. Organized education of the hearing impaired, first in 1750s, was established in Paris by Abbe Charles Michel de L'Epee, a French priest.

Abbe L'Epee is known the father of sign language (American Sign Language, 2009). The father of oral method, Samuel Heinicke is a German educator, opened the first oral public school for the deaf in Leipzig in 1777. He taught his students how to speak by having them feel the vibrations of his throat when he spoke (Berke, 2009).

During the early 1800's, Thomas Hopkins Gallaudet who was an American pioneer in the education of the deaf went to England to learn a teaching method suitable for instructing deaf students. In England in Braidwood School's instructional methods were oral, reliant on speech and speechreading but teachers were unwilling to share the method. While Gallaudet was in England, a French priest, Roche-Ambroise Sicard, a teacher of the deaf, was on tour demonstrating his sign language method. Gallaudet impressed with Sicard's sign language method. He brought Sicard's sign language methods to America (Zapien, 1998). Today, there is a well known institution in U.S.A is known as Gallaudet University.

In 1880, the two different educational methods (sign and oral) did battle at the Conference of Milan. The conclusion of the Conference was that the oral method was superior (Lane, 1992). Sign was forbidden because educators believed that if a profoundly deaf child signed, he would not learn how to speak since speaking is a difficult skill for a deaf child to learn (Schein & Stewart, 1995). English is a truly difficult language to speechread. Many words look identical upon the lips. In order to speechread effectively the individual must have an excellent grasp of the English language. Most deaf people in the time period being discussed had never heard English and did not have a grasp of the language, yet they were expected to learn their lessons and learn to communicate without having the necessary tools to do so. For many deaf individuals, the frustration caused by this system and the poor scholastic results achieved by the system added fuel to a bitter situation. Oral method has not been found successful for profound hearing impaireds because residual hearing is essential for oral education. In this period of the deaf education methodology, the technological developments in hearing aid technology were insufficient yet. The first electric stimulation of the acoustic nerve in humans took place in late 1930's.

For at least a century ago, the education of deaf children was polarized into two main camps, the manualists (those who sign) and the oralists (those who rely on speech and lipreading for communication). In the early 1960s William Stokoe wrote and published Sign Language Structure. This work proclaimed that American Sign Language (ASL). Total Communication also emerged about this time (Zapien, 1998).

Today, in United States, the attitudes towards teaching deaf children have changed drastically. Generally the professionals feel that some form of signing, preferably ASL, is useful for the deaf children. Quite a number advocate using the bilingual model. One professional writes: "What the United State desperately needs bilingual program for deaf kids in which ASL via signs and English via cues are given equal importance. (Zapien, 1998)"

Although all the developments at technology and success of verbal communication of hearing impaired with the cochlear implantation, American authors' insistence is very incomprehensible. It seems that there are some profits behind their assertions. "A parent respondent shared this insight "No one has one right way to raise a deaf child, any more than anyone has one right way to raise a hearing child. The politics involved in deaf education are nauseating and who suffers the most in the end are the children themselves. (Zapien, 1998)"

2.6 General Over View of Methods Applied in Turkey

The cochlear implant programmes within Turkey are proliferating. This proliferation means that the number of individuals involved with the rehabilitation and habilitation of the implantee is increasing (Şerbetçioğlu, 1998).

The developments regarding the hearing impaired in our country are much more pleasing in terms of both the medical field as well as the deaf education aspects. These children, after the cochlear implant operation, start to learn the verbal language through auditory/verbal method in rehabilitation centers. There are boarding schools for the hearing impaired children in our country. These schools

teach the sign language. The managers and instructors in these schools report that they experience problems such as; children being abstracted from their families and the society and being together with only the hearing impaired children who know only sign language, feeling alienated by being unable to establish dialogues with even their family members when they visit them in holidays. There was a debate between managers and instructors who were responsible for deaf education in this country. The suggested solution was directing the hearing impaired children without mental defectiveness to orientation program in regular schools; through joining programs provide hearing impaired with the opportunity to study in same classes with their hearing peers. By the means of orientation program, they were able to learn reading and writing in mainstream schools without being behind their peers, additionally they are supported with special training in rehabilitation centers, they even succeed at universities (Aydoğdu, Personnel Commication, 1998).

2.7 Hearing Assistive Devices

Nearly all hearing impaired patient who have a conductive or sensorineural hearing loss can benefit from hearing aid, or a tactile aid. It is important to encourage patients to obtain the appropriate prosthetic device (Tyler, 1991).

2.7.1 Hearing Aid

Hearing aids must be adjusted for the individual needs of each patient. Common hearing adjustments include the frequency response, the output limitation, the gain setting, and sometimes the compression characteristics. The appropriate frequency response be often set by formulae based on the patient's audiogram (Byrne & Dillon, 1986).

2.7.2 Cochlear Implant

Cochlear implants can provide some hearing to profoundly deafened patients who receive little or no benefit from hearing aids (Gantz, Tyler & Knutson, 1988; Tyler & Moore, 1989).

The first electric stimulation of the acoustic nerve in humans took place in late 1930's. In 1957, a French group implanted microinduction coils in two patients and used these to stimulate the auditory nerve. However, there were technical failures and the production of the device was discontinued. After further development in Sidney in 1982, devices which were developed allowed the patients to understand running speech without the need for lipreading.

A cochlear implant is a device that is able to receive processed sound signals and then stimulate the acoustic nerve so that the person is able to perceive these sounds (Figure 2.1). The device consists of a microphone, speech processor and transmitting coil worn behind the ear. Implanted in the mastoid bone behind the ear is a receiving coil. This is connected to a demultiplexor and in turn to a 22 electrocode lead that is inserted into the cochlear.

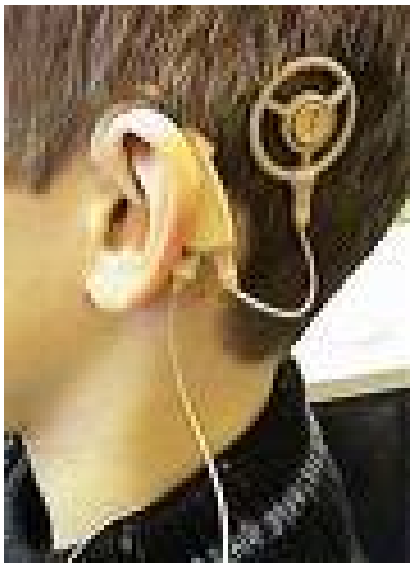

Figure 2.1 Cochlear implant device

2.8 Educational Methodology Applied in This Study

Educational approaches for hearing impaired can be summarized as sign language, bilingual, total communication, auditory/oral, auditory/verbal. These models can be schematically expressed in the Figure 2.2 as follows.

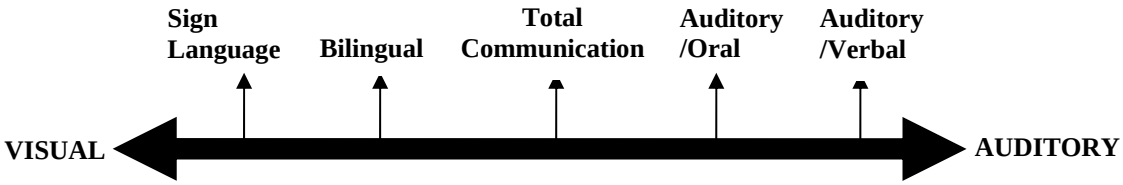

Figure 2.2 Polarized educational approaches for hearing impaired

Of these communication modes, on its own sign language, does not necessitate cochlear implantation procedure. The most compatible approach is Auditory/Oral and it emphasizes the optimum use of residual hearing in conjunction with lipreading cues. Sign language may be helpful for children with severe and profound hearing losses but there are only limited number of people who can use and teach sign language. Through use of oral communication, hearing impaired children prefer to use speech instead of sign language. Although these children have also been prelingualy hearing impaired (deaf from birth), they fit into society better by learning to speak with the help of a hearing aid and with the support of education. The communication barrier between the deaf and hearing worlds can be broken down by this way (Şerbetçioğlu, 1998).

While children with mild and moderate sensorineural hearing loss may benefit from amplification with hearing aids, children with severe and profound hearing losses usually need cochlear implantation. Worldwide the number of children with cochlear implant is increasing and there are lots of ongoing studies on this topic. After adequate therapy of those children oral language education is proper and becoming widespread. The earlier a child is given hearing aids or cochlear implantation performed better (for instance before 18 months old).

When hearing impairment is diagnosed early in life, the hearing device is used and the oral education is given, hearing impairment is no more a reason of person's isolation from society.

2.9 The Difficulties in Audio/Oral Education of the Hearing Impaired Children

The success in technological developments taking the hearing impaired individuals to the position of hearing individuals. Applying these technological developments together with the surgeries performed in the medical field is a success itself.

Despite these positive reinforcements, such big successes are yet the starting point of the path the hearing impaired individuals are required to cover. Hearing impaired subjects do not start to hear as soon as the device is implanted and take as much as 3 to 4 weeks to be fitted with external device.

The implanted individual cannot start hearing and learn talking all by herself/himself as it is in hearing children. Unless a verbal communication education is given, hearing impaired children can not communicate orally even they have cochlear implant or using hearing devices. Because for a healthy baby start hearing the sounds in her/his mother's womb at 5 months. But for hearing impaired baby, since there is no sound stimulus transmitted to the brain, the section of the brain which could be reserved for hearing is devoted for another function. After implanted, sound stimuli are transmitted to the brain and channel for hearing speech sounds ought to be opened in the brain.

No matter how early it is diagnosed, the brain would not have any improvement unless it learns detecting the digital sound transmitted from the cochlear implant. The individual would learn interpreting such sounds with the training provided under the support of a large team consisting of professionals including educational audiologist,

clinical audiologist, otologist, speech pathologist, psychologist and teachers of the deaf.

Early intervention is a key factor. “For language to be successful with deaf children (no matter what the educational approach), programs of early intervention must take place during the critical language-learning years of birth through 6. In fact, if children start auditory stimulation after age 3, the process is progressively more difficult. Speech and language acquisition process is a “use it or lose it” skill (Zapien, 1998).

Even early identified infants -12 to 16 month old children- moderate/profound hearing loss exhibit delayed receptive and expressive language skills in oral and signed language (Vohr & etc, 2008). The results demonstrate that children with cochlear implants perform at significantly lower levels on the majority of the cognitive tasks (Lyxell & etc, 2008).

What is more, this difference (acquiring the language between hearing loss children with hearing coevals) get greater as time passes. Hearing loss children typically exhibit literacy difficulties (Colin, Mangan, Ecalle & Leybaert, 2007). The reading skills of hearing loss children have typically been delayed and this delay has been found to increase with age (Archbold & etc., 2008). “Cochlear implanted users were well integrated into the hearing world, concerning their schooling and post-graduate development. However, their career perspectives are still not satisfying (Huber, Wolfgang & Klaus, 2008)”. As the learning capacity decreases every passing day, the difference between him/her and his/her peers will increase and compensation will be impossible. This deterioration stems from the inadequate education given during the growing period when learning is at its maximum. The education she/he will be given during this period will not only help her/him to develop the same language level as her/his peers but also provide a better life for her/him. Especially during the preschool period when the intelligence and language development is at its maximum.

The hearing impaired children just start to perceive the voices at a stage when healthy babies learn to talk. But hearing impaired children at about 2 and 3 years old do not experience the same language acquisition phase. At this age range, hearing impaired children are at least 2 years behind of their normal hearing peers. A hearing impaired 2-3 years old child does not know yet that everything has a name. The education of the hearing impaired to be provided for the preschool children shall be a study that would be fulfilled together with concept teaching and hearing start to perceive voices. In this period, the education of preschool hearing impaired children is a very complicated and difficult process that the concept teaching and language acquisition are handled together; and this process should be continued by considering their mental development process compared to their peers (Sarmaşık, Şerbetçioğlu, Dalkiliç, Kut & Çebi, 2007).

The education of a hearing impaired child is initiated with a word. It is different for every child. The first word they learn is named as the “key word”. “Key word” opens the gate to the world of normal hearing people. All the words they will learn afterwards would be built on such a key word. Learning such key word takes months. This is a very tiring process for the educators in that they repeat the same word to teach persistently. Its difficulty is obvious thinking of saying a ball for 92 times only in 5 minutes in one session (Anadolu Üniversitesi, 1996).

In brief, the difficulties could be summarized as bellow:

- Difficulty in explaining abstract concepts, actions and time concepts,
- Inability to understand the word (concept) when used in a sentence,
- Situations when it is difficult to make available the materials with respect to the subject to be explained,
- Forgetting what was taught quickly,
- Necessity to make so many repetitions,
- Rapid distraction of interest in the classical explanation because they do not hear properly

As a result, hearing impaired children need to be supported with special supplemental education continuously, especially during the preschool period when the intelligence and language development is at its maximum. However this education is tiring and difficult work for both children and educator.

2.10 The Role of Computer in Hearing Impaired Children's Education

The function of any organ missing in our body is undertaken by other organs. As the auditory sensitivity of visually impaired persons increase, the eyesight of hearing impaired persons develops much more than individuals who can hear. The hearing impaired people complete many words they do not hear by lipreading; in a way "they hear by seeing". Since the computers provide a visual environment, it is an attractive and pleasant device for the hearing impaired. Computer assisted instruction offers interactive, customizable, and measurable training environment for disabled children at language learning (Huntinger, Bell, Daytner & Johansan, 2006; Luckvich, 2008). The education of hearing impaired people, which is very difficult, can be also made much more easily through this aspect of computers.

Computer is beneficial in all the fields we listed above as:

- Concepts that are difficult to be taught (actions, abstract concepts) can be presented easily
- Interest can be kept active all the time through animations and simulations
- Various options can be presented when repetition is needed and thus same information can be repeated without boring
- The opportunity of correcting the faults is provided by presenting visually through audio analysis graphics in remedying speech disorder (pronunciation)

2.11 AURIS As a Computer Based Instruction Tool for Hearing Impaired

In this section, the technological developments and the developments in medicine for hearing impairment is evaluated. Technological developments on the ear devices increasing the voice quality and reducing noise are being produced; and the development of better devices are goes on. Moreover, a new technology the cochlear implant is getting common gradually in the whole world. The cochlear implant operations are providing successful results even though it is yet a new technology. It is ensured to make the hearing impaired, hear through the cochlear implant. The barriers between the hearing impaired and normal hearing people are being eliminated every passing day.

Although this positive developments, learning verbal communication is not so easy for hearing impaired. The difficulties of the auditory/oral education method is investigated and summarized, deficits and needs are supplied, in this chapter. As a contribution in the field of hearing impaired through the computers, an instructional tool is decided to be preparing to support education for hearing impaired children which can meet these difficulties at language learning, improve their verbal communication skills.

To prepare such a instructional tool, firstly, as a literature analysis, what kind of studies were performed until now with regards to the training and language education of hearing impaired in the field of computers in the world and Turkey is searched. The results of search in the following section were presented.

CHAPTER THREE
COMPUTER BASED INSTRUCTION

3.1 Computers in Education

Computers in education have moved out of luxury and become a necessity (Reddy, 2008). In today's schools, computers completely change education and the delivery of instruction to students, one-to-one teaching settings through computers are established at the schools (Meyer, 2007).

The concept of using computers to aid learning and facilitate academic work is called Computer-Based Instruction, which means teaching with computers. It has been about 50 years since educators and computer scientists began using computers for instructional purposes. Educational computing began with a few, large, government-funded projects on mainframe and minicomputers in 1960. Educational computing existed only at large universities and was largely restricted to reading and typing text. In 1978, the first widely available microcomputers were released, most early microcomputer courseware was designed for the Apple II for use in schools These increased the educational computing materials' popularity in the schools (Alessi & Trollip, 1991).

3.1.1 Major Types of Computer Based Instructions

Taylor (1980) was one of the first authors classifying instructional computing activities.

Nowadays, major types of Computer Based Instructional programs are:

- Tutorials
- Drills
- Simulation
- Games

- Test (Practice)
- Problem Solving
- Animations

3.1.1.1 Tutorials

Tutorials are used in almost every subject area from the humanities to the social and physical sciences. They are appropriate for presenting factual information, for learning rules and principles, and for learning problem solving strategies.

3.1.1.2 Drills

This type of instructional models drills provide practice. They are applicable to all types of learning, assuming that initial presentation and guidance has already occurred. As a difference form classical drills, computerized drills may be applied to simple paired-associate learning, such as spelling or foreign language word translation; to verbal information, such as definitions of historical facts, scientific concepts and principles. They do not teach but merely provide practice with the assumption; simple problem solving activities such as arithmetical facts; or complex problem solving activities such as problems in the physical and social sciences (Allessi & Torllip, 1991).

3.1.1.3 Simulations

In a simulation, student learns by actually performing the activities to be learned in a context that is similar to the real world. In an educational context, a simulation is powerful technique that the teachers about some aspects of the world by imitating or replicating it (Allessi & Torllip, 1991).

3.1.1.4 Instructional Games

Games are similar to simulations; provide an environment that facilitates learning or the acquisition of skills. Conversely, games are characterized by providing the student with entertaining challenges. (Allessi & Torllip, 1991).

3.1.1.5 Test (Practice)

Tests are the instructional models purpose determining what a student knows and does not know; rank ordering students in terms of performance; deciding who should be employed; assigning grades; admitting to collage; diagnosing mental problems (Allessi & Torllip, 1991).

3.1.1.6 Problem Solving

This type of instructional models can be used in the learning process, because of their ability to provide "what if" situations, sometimes are used to teach management processes (Dowd & Bower, 1995). Problem solving instructional models bring about an environment in which mediation effects are as important as in productivity. They are more likely to insight (Brinkman, 1984).

3.1.1.7 Animations

Animations have been used in instruction to serve or assist one of three functions: attention gaining, presentation and practice (Rieber, 1990).

3.1.2 Effectiveness of Computer Based Instruction in Education

As the number of computer aided education software is in a steady increase, the opportunity to evaluate the success of computer based instruction is rising up. Hundreds of research studies have been performed in an attempt to prove that using a

computer to teach something is better than using a book, a teacher, a film or some other more traditional methods (Alessi & Trollip, 1991; Meyer, 2007).

For an effective instruction four phases should be present:

- Presenting information
- Guiding to student
- Practicing by student
- Assessing student learning

3.1.3 Computer Aided Educational Tools

Computer Aided Educational Tools are the applications of Computer Based Instructions. Computer aided educational tool introduced in this thesis is called AURIS. AURIS is Tutorial type of Computer Based Instructions.

Tutorials aim to satisfy generally engage in the first two phases of instruction: Presenting information, guiding to student. But tutorials usually do not engage in extended practice or assessment of learning. They take the role of instruction and guiding the learner in initial acquisition (Allessi & Trollip, 1991).

With AURIS we aimed to guide hearing impaired student in verbal communication.

3.2 Computers in Early Childhood

In recent years, the role of computer based instruction is determining in early childhood.

Parents' concern that their children are watching too much television has been replaced by the fear that they are spending too much time in front of the computer. Nonetheless, with monitoring and developmentally appropriate software, computer technology, can provide a unique and substantial contribution to young children's

learning and development while building their confidence in using technology (Giles, 2007).

At least computer is providing an interactive learning environment for the children when compared with television. Children are not passive audience at computer environment as is the case with television. Because computer provide an interactive phases; for example if children do not succeed, they can pass to the next step. In addition, instructional tools teach, test children's learning level and also can orientate them according to their success.

The benefit acquired from computer based instruction increases as children's age decreases. Findings of a research conducted about the effects of a computer based teaching employed in beginner level reading program with a group of kindergarten and first grade students are remarkable. Watson and Hempenstall (2008) examined computer based reading program with a group of 15 kindergarten and grade 1 students. Kindergarten students in the intervention group demonstrated significant improvement over time on letter-sound fluency, non-word decoding and oral reading fluency when compared to the outcomes for a similar comparison group. However, Grade 1 students demonstrated significant improvement as well but these improvements are not significantly greater than those for the grade 1 comparison group. It is concluded that kindergarten students gained the most benefits, and that at risk students may represent fruitful target audience.

Preschool children's learning success at the computer environment is really amazing. Actually, it is a basic principle to teach one concept at a time in preschool instruction. When a preschool child is receiving computer aided instruction he/she is required to learn 4 concepts at the same time. These are:

1. Computer use,
2. Use of software (Directives: Start, Forward, Back, Back to Top, etc.)
3. Concept to be taught (music, mathematics, science, etc.)
4. Language used in the instruction

The children are able to learn these listed elements all at once without difficulty and having fun, additionally, they accomplish. As at this age (preschool period) the learning capacity of the child is maximum to learn anything (computer, language, mathematics, music, etc…), moreover the acquired information becomes more permanent.

3.2.1 Classic Education versus Computer Based Instruction for Preschool Children

Computer technology is becoming available for teachers and students of all ages, including increasingly those in early childhood classrooms (Haugland, 1997; Işıkoğlu, 2002).

Students' abilities to search, analyze, and synthesize information by using computers has became more and more important, and the belief that students should acquire this knowledge and ability during the school years more prevalent (Lim, 2008).

Today in Turkey, the instructors are awere of the fact that the importance of preschool period. Elementary schools started to open preschool classes within the last 10 years. However, it would not be appropriate for the children in this period to be taught by using classical ways of teaching as is the case in today's schools. So, education settings for this period are being investigated. Nevertheless, even though the teachers support the classes with activities such as music, drawing and games, they can not depart from an education close to the classical education setting. Computer is a compact instrument that can meet all the educational requirements including music, drawing and many others. Computer based instruction is available to provide the children with a learning setting equally good as a game setting flourished with audio and visual elements.

Haugland (1992), Nir-gal and Klein (2004) summarised benefits of computer environments for children as follows: "3 and 4 year-old children who use computers

regularly in the classroom have significantly greater developmental gains in intelligence, nonverbal skills, structural knowledge, long-term memory, manual dexterity, verbal skills, problem solving, abstraction, and conceptual skills when compared to children without computer experiences in similar classroom".

Furthermore, this kind of learning is more enjoyable and long-lasting. Research results show that comparison of computer aided education for preschool children is more successful than the traditional education (Çakır, 1998; Kaçar and Doğan, 2007; Ljung-Djarf, 2008).

3.3 Computers for Language Learning

Computers were introduced into language learning labs in the educational setting in the 1950s (Hindel, 1966; Lewis, Whitekaer, & Julian, 1995).

Using computer for second language learning is called Computer Assisted Language Learning (CALL). Warschauer (1996) stated that the effectiveness of CALL, can not reside in the medium itself but only in how it is put into use. From this statement, it is apparent that computers in the language development spectrum can be used in a variety of ways. One way could be just using drill and practiced instructional methods, others would include creating presentations, movies, interactive presentations, story telling, and so forth. Kindergarten classes can practice with letters and symbols on the same computer where that students in grade 5 solve detective cases.

In former computer language learning labs, students was required to sit at a terminal alone with headsets, listen and repeat what was stated, to view and again follow the same pattern (Roblyer,1989). Since computer aided instructional tools became more sophisticated and students were able to record their voices, see, and hear, the spelling of what they are recording (Bently & Wats, 1994).

3.3.1 Computers for Preschool Children's Language Learning Education

Nowadays, computers from the university labs, slowly began to enter public high schools and finally the elementary grades for language education students (Pacheco, 2006).

Halliday (1973) defined the functional theory of language as "one which attempts to explain linguistic structure, and linguistic phenomena, by reference to the notion that language plays a certain part in our lives; that it is required to serve certain universal types of demand". He identified seven functions in child language:

- Instrumental: language is used to satisfy personal needs and to get things done; e.g., "Candy, Mommy"
- Regulatory: language is used to control the behaviour of others; e.g., "Go out"
- Interactional: language is used to get along with others; e.g., "You want to eat?"
- Personal: language is used to tell about themselves; e.g., "I am playing now"
- Heuristic: language is used to find out things or to learn things; e.g., "How did you get that?"
- Imaginative: language is used to pretend or to make believe; e.g., "Let's pretend this is a hotel"
- Representational or Informative: language is used to communicate for the information of others; e.g., "I'll tell you how to draw a dragon".

To Halliday, a young child tends to use language in one distinct function at a time, while an adult often combines several functions in one instance of language. For this reason, this seven-category theory provides an adequate model to understand the relatively unambiguous functions in a child's use of language.

Application of Halliday's functional theory of preschool children's language patterns was done in the computer environment by University of Central Arkansas. It was applied to the data collected in the current study to unveil the nature of preschoolers' language in the computer environment (Feng & Benson, 2007). The authors developed and employed a coding scheme that consists of the seven functions.

The following are the questions their study set out to answer:

1. Are Halliday's seven functional categories all present in the language produced in this preschool classroom's computer environment?
2. What is the most frequently used function in this computer environment?
3. Do Halliday's seven functional categories cover all the language produced?

Summary of Findings:

1: Although Halliday's seven functions were based on his analysis of child language produced in the home environment between a mother and a child, analysis shows that all the seven functions also exist in the language generated by preschool children in the computer environment.

2: The results show that the regulatory function is the dominant pattern in the computer environment followed by heuristic and representational.

3: Except for some interjections, like "wow," "hey," and "okay," almost all the utterances fall into one of the seven categories. It proved to be an exhaustive framework to understand the language produced by young children.

The study of Feng and Benson (2007) supports Halliday's classification of child language into seven functions in computer environment. All the seven functions were found in the data of their study, and except for such interjections as "Wow," "Hey," and "Yeah," almost all language fit one of the seven functions. As a result they argued as Halliday (1973), "Our conception of language, if it is to be adequate for meeting the needs of the child, will need to be exhaustive". Limitations of their study are that they did not investigate their language patterns in non-computer environment. Comparing the language produced in various settings to determine whether environment plays any role in the language functions that children use is their future research.

3.4 Impaired Children and Computer Based Instruction

Computer based instruction presents an education setting eliminating the barriers for impaired children.

A spastic impaired child can not write using pen and paper but he/she can write on the computer using the keyboard and mouse. Writing on the computer may be facilitated even more through the software prepared towards such children, by dragging the words or sentences on the screen.

For the children having hyperactivity disorder and distractibility, a software supported by colourful, visual pictures, videos and sounds increases the time they focus their attention. Also software prepared with a continuously changing setting and changing characters would increase the period they focus attention.

For the children having visual impairment, the fonts sizes may be expended to ensure them too see easier. Special software prepared for colour-blind children may be used firstly for testing whether they are colour-blind in a game setting easily. The colours in the software may be prepared in a way to eliminate their distress because of their defects.

Mentally retarded children and children having learning disability would find the possibility to repeat as long as and as much as they wish in a way complying to their level of perception in the computerized learning setting. These children having difficulty in learning would learn in the computer setting and they would not be ashamed or embarrassed and their personality would not be offended as their defects would not be revealed in front of their peers contrary to the classroom setting.

3.4.1 Computers for Disabled Children's Language Learning

Computer based instruction offers interactive, customizable, and measurable training environment for disabled children at language learning. One of them is Childhood Emergent Literacy Technology Curriculum (ELiTeC), which was designed to replicate, on a broad scale, the results of earlier research in which a curriculum model was developed, implemented, and studied in preschool classrooms for children with disabilities or those at risk (Huntinger, Bell, Daytner & Johanson, 2006). ELiTeC was based on the assumptions that technologies provide access to literacy activities that benefit children with disabilities and an integrated curriculum approach offers a meaningful context for learning. The original study EliTeC1 encompassed 255 children and 8 teachers over a three-year period. During this time span, EliTeC2 was replicated in 17 classrooms, with 18 teachers who served 438 children. Both quantitative and qualitative data were collected. Findings of the EliTeC2 study demonstrated the importance of allowing adequate time for an innovation to be integrated into practice. The longer teachers used the curriculum model the more positive were the results related to both model fidelity and children's gains in important aspects of literacy.

Another study is computer assisted instruction for teaching vocabulary to a child with autism. Children with autism have difficulty communicating. Their limited vocabulary reduces their comprehension of language and their use of speech to express thoughts and needs. Increasing vocabulary is important to improve communication skills. These children do not learn language like typical children. They have limited joint attention skills and impaired basic learning skills that impede

their communication. Specialized instruction is necessary to help them learn language. They need to be explicitly taught words, phrases, and sentences. In their study (Luckevich, 2008), the use of computer aided instruction by a child with autism to learn words was investigated. The First Words II software by Laureate Learning Systems was used in a preschool classroom. The case provides a comprehensive description of the participant including his pre-treatment skills, treatment behaviours, and test results. Results gathered from the Computer Aided Instruction treatment indicate that the participant made progress toward learning new object labels. Additional skills beyond the content delivered by the Computer Aided Instruction were also demonstrated by the participant. These skills included increased motivation, strengthened positive relationship with a teacher, improved joint attention, sustained concentration with an instructional task, and verbal and motor imitation. The participant enjoyed using the Computer Aided Instruction in the classroom.

The education of hearing impaired people can also be made much more easily through this aspect of computers. For the hearing impaired children, computer based instruction is beneficial in terms of providing a visual learning setting, they would be able to advance their language learning skills in order to use sign language or verbal language. Furthermore, they would be able to eliminate their vocal and speaking disorders at the auditory environment provided by computer based instruction.

In addition, in any impairment group, the possibility of a child having more than one impairment is high. There may be a visual defect or mental retardation not yet diagnosed in a hearing impaired child. Therefore, educational software for the impaired children should be designed in a way to support more than one impairment group as well.

3.5 Literature Review about Computer Aided Tools for the Education of the Hearing Impaired

When the software and papers published in the international literature were investigated, some computerized lipreading assessment and training systems for English language were found. However, when these tools are examined, it is seen how their approaches to education are distant from educational principles for hearing impaired children as basically all these tools treat words as a single and independent units.

In the national literature, there are some computerized studies of sign language but there is no computerized lipreading system used for hearing impaired children.

On the other hand, there are some computer aided learning materials for articulation disorders designed for Turkish in the literature. One of them is called "Computer Aided Learning Material on Articulation", which shows visual cross-section of face as pronunciation positions of 29 letters in our alphabet. The effectiveness of the tool has been tested both on adults (Karal, 2009) and as well as on preschool children (Karal & Aydın, 2007). In adult group, this tool was tested on six candidates who have articulation problems. After a twelve weeks training by the tool, each candidate's success of correcting pronunciation for each phoneme was measured. Success scores for each candidate were measured as percentages. Results were presented separately for each candidate, for example "N"s success increased from %32 to %84. The tool is applied to preschool children who were attending primary first year (aged 6-7) in their school laboratory. Teacher's observation was taken as a criterion for children success: "Although children did not know how to use computer and the software, they were integrated to the program easily and enjoyed to study with it. After four hours of training with two children who have articulation problems, it was observed that one of the children was able to distinguish "b" from "be". Other improved pronunciation was about "r" before training as "y". The tool is useful for children particularly for those having articulation problems to recognize their mistakes, and articulation differences between true and false pronunciation"

Another tool for speech and language disorders in national literature is “Speech Recognition Method For Speech Therapy” developed by Oytun and Arslan (2004). In their study, speech recognition methods were investigated for computer assisted speech therapy in Turkish. A Turkish database was designed and collected from native speakers for evaluations. Initial experiments indicated 84.9% correct recognition rate for isolated phonemes and 94.2% for isolated words when the system was tested in speaker-independent mode. A correct recognition rate of 97.2% was achieved with speaker-dependent training for a list of Turkish words used in speech therapy.

AURIS, has been designed to teach verbal communication, improve the child’s language learning skills and concept acquisition during his/her preschool education period. With the AURIS as an instructional tool, while guiding and supporting the education of hearing impaired children, we also aimed to lessen educators’ difficulties according to their needs, and to provide enjoyable atmosphere for both the child and the educator.

AURIS, distinctly from the other software designed for the hearing impaired as included in literature, is unique in terms of having the feature of possibility to be changed based on the individual characteristics and areas of interest of child. AURIS, with this feature, encourages the child for the learning environment and enables the child to identify himself/herself with the subject sought to be taught. Furthermore, the software is unique and peerless in terms of the ability to individualize (customize) it to the child for including the objects the child is interested in and even local or regional objects and also in terms of providing the opportunity to expand the software by including as much objects as desired.

CHAPTER FOUR
AURIS:
COMPUTER AIDED EDUCATION AND LIP READING TRAINING TOOL FOR HEARING IMPAIRED CHILDREN

In oral communication, speech signal is essential. However it is not necessary to hear every sound to understand a speech, because there is also a great emphasis on lipreading, facial expressions and gestures. Ambiguities in the spoken message, brain use the redundancies of language context, lipreading, facial expressions and gestures to make good guesses. A hearing impaired person needs redundancy for understanding to speech more than normal hearing.

4.1 Theory of Software Design of Hearing Impaired Children's Education

There are three major sources of information in normal face to face communication: first and most influential one is auditory, second one is visual and the last one is contextual source. To be fair, none of these can convey the information alone (Şerbetçioğlu, 1998).

Design theory is examined into four components:

- Lipreading
- Language Context
    - Concept
- Auditory

4.1.1 First Component: Lipreading Aspect of Auditory/Oral Methodology

Lipreading is one of the main phases of Auditory/Oral Method therapy includes:

- listening skills (instructor covers their lip movements)
- build language through listening

- natural gestures are accepted
- no sign language used

4.1.1.1 What is Lipreading?

Lipreading, is a technique of understanding speech by visually interpreting the movements of the lips, face and tongue with information provided by the context, language, and any residual hearing (Canalis & Lambert, 2009; Wikipedia, 2009).

Speechreading the ability to understand a speaker's thoughts by watching the movements of the face and body and using information provided by the situation and the language" Sound recognition is not the component of speech reading. Speechreading includes gestures and body language (Kaplan, Bally & Garretson, 1985).

4.1.1.2 How Lipreading Can Be Used With Hearing?

Many hearing impaired people with mild or moderate losses have difficulty understanding speech no matter how load it is. Sometimes best hearing aid can clarify only vowels but not high frequency consonants. When any of these problems exists, the individual communicates best with a combination of speechreading and aided hearing (Kaplan, Bally & Garretson, 1985).

4.1.1.3 Principles of Lipreading

People with ear-strain should spare the hearing as much as possible, and, instead of straining the ear to catch what is said, they should watch the lips more. In other words, the eyes should be called upon to help the ears…. encourage them to use ears and eyes in fullest cooperation, one helping the other (Barnes, 1909).

For lipreading, both the eyes and the mind must be trained, but mind-training is the more important factor (Barnes, 1909).

Lipreading Training (Barnes, 1909; Nitchie, 2007):

- **Word understanding:** A correct understanding of an idea is possible without a word-for-word accuracy. That is the way the baby understands what is said to him. Example: I would say to my little boy, a year and a half old, "How does daddy shave himself in the morning." That he understood every word was not possible; probably "daddy" and "shave" were the only ones he really knew. But that he understood what I said he made evident when he went through the motion of shaving his own face with his finger.
- **Sentence:** The importance of training the visual memory is clear from the fact that often the lipreader will get the first part of a sentence from the last; that is, the understanding of a few words toward the end of a sentence, aided by the memory of preceding facial movements, will enable the lip-reader to construct the whole. Sentence practise is always good for developing this power; but at no time should the pupil be allowed to interrupt the teacher until either a whole sentence, or at least a clause, has been completed.
- **Vowel and consonant exercises:** Other practice for developing the power of visual memory will be found directed under the vowel and consonant exercises where the pupil is required to carry three, four, or even five unrelated words in mind and to repeat them in order.
- **Practice:** The eyes must work by habit, and to form these habits much repetition in practise is necessary. To give an exercise once may train for accuracy, but not for subconscious accuracy. It is absolutely essential, therefore, that the pupil aiul the teacher should go over and over and over things until they are truly mastered.
- **Mind-training:** The essentials in training the mind are to develop (1) synthetic ability, (2) intuition, (3) quickness, and (4) alertness. The method of mind-training should aim to develop this power of grasping thoughts as wholes, and to avoid strictly anything that will enhance the opposite tendency of demanding verbal accuracy before

> anything is understood at all. Minds of the latter type are literal, analytical, and unimaginative. However analytical, have some synthetic powers, some ability of putting things together, of constructing the whole from the parts, of quick intuition. It is by developing these powers that real success in lipreading can be attained, and it is by working along these lines that the surest way is found in the end to the understanding of every word. All this work for the eyes is in its essence analytic. The conscious work of the lipreading, however, must be synthetic. Hence the eyes must be trained to do their work subconsciously.

During lipreading, eyes analytically determine coordinations of the lips, and then brain evaluates these coordinations and perceive them as an objects (substance).

4.1.1.4 Limitations of Lipreading

Each speech sound (phoneme) has a particular facial and mouth position (viseme), although many phonemes share the same viseme and thus are impossible to distinguish from visual information alone. Sounds whose place of articulation is inside the mouth or throat are not detectable, such as glottal consonants. Voiced and unvoiced pairs look identical, such as [p] and [b], [k] and [g], [t] and [d], [f] and [v], and [s] and [z] (American English); likewise for nasalisation. It has been estimated that only 30% to 40% of sounds in the English language are distinguishable from sight alone; the phrase "where there's life, there's hope" looks identical to "where's the lavender soap" in most English dialects (Wikipedia, 2009).

In Turkish, the phonemes that can not be differentiated using lipreading as follows: /p,b,m/ or /ş,j,c,ç/ (Şerbetçioğlu, 1998).

4.1.1.5 Technological Developments on Lipreading

Nowadays software is developed in the area of lipreading recognition instead of the lipreading instruction. These softwares which for the recognition of lip movement of the articulators' -wag, tongue, jaws, and lips are generating the measurable characteristics of visual speech- by computer is called Speech Recognition.

Moreover, nowadays, speech recognition software can also distinguish languages. Scientists have developed a computer that can not only read lips, but can tell the difference between languages Figure 4.1 (Rutherford, 2009).

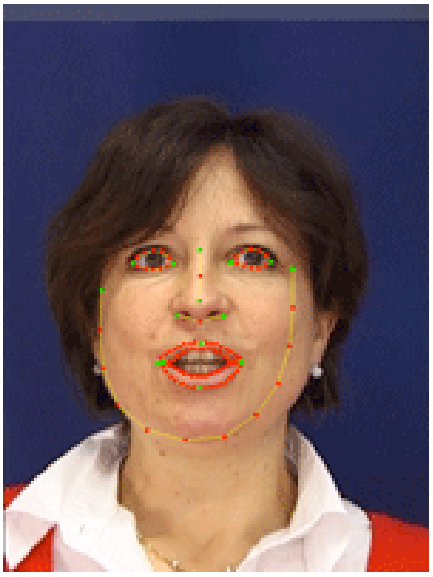

Figure 4.1 Speech recognition tool

As a result this technological developments support the thesis hypothesis about the gaining of lipreading. If lip movements can be modelled and generalized for software, hearing impaireds can gain benefit from lipreading in spite of to any limitations of lipreading.

4.1.1.6 Redundancy in Speech

There is redundancy of the information in speech. Redundancy in speech can take many forms. These are acoustic and non acoustic cues. Frequency, intensity and the duration of the sounds are acoustic cues. Non acoustic cues are gesture, body language and lipreading. These elements of speech may or may not utilized by normal hearing subjects but it is important to know the nature of these redundancies and how to make use of them when dealing with hearing impaired patients (Şerbetçioğlu, 1998).

What can be seen on the lips is limited, and because of many ambiguities in the spoken message, you can use the redundancies of language- situational clues, gestures and facial expressions- to make good guesses. Knowledge of what the language structure permits allows you to fill in missing words or change words that do not make sense. For example (Kaplan, Bally & Garretson, 1985):

Speaker says: Where have you been?
You spreechread: Where are you been?
You think: Are does not make sense. It must be have

While the speaker is talking, you may mentally replace words that seemed correct earlier in the conversation but now don't make sense because you have more information. So speech reading is combination of what the eyes can see and the mind can correctly fill in. The work of eyes is called the analytic component and work of the mind is called the synthetic component. Development of the analytic component is called eye training while development of the synthetic component is called mind training. Mind training is by far the most important part of speech reading. A good speechreader can take whatever is seen on the speaker's face, combine it with gestures, body language, facial expression, linguistic rules, situational clues, and whatever can be heard and make some sense of it.

4.1.2 Second Component: Concept

AURIS is designed to educate prelingual hearing impaired preschool children who do just started verbal communication, and can not talk at all. The education of the hearing impaired preschool child in oral method starts with concept teaching. In this respect, concept teaching is handled as a second component in this study.

The preschool hearing child's language acquisition period starts with concept learning. A child starts language learning with single words and produces the language in the form of individual words. Then by combining these words, he/she can utter two and three-word sentences.

Much as in case of a hearing child who starts learning to speak with single words, the hearing impaired child follows the same pattern. But, unlike a normal hearing child learning to speak, a hearing impaired child if not fitted with hearing aid or not provided with cochlear implant, can not begin using the sounds which have been heard and percepted. If the speech sounds can not transmitted to the brain before the cochlear implantation, the section of the brain normally reserved for hearing and speech perception probably serves another function in a hearing impaired baby. After implantation, sound stimuli are transmitted to the brain and a section for hearing ought to be opened in the brain. When children are 2-3 years old, it is evident that the hearing impaired children are at least 2 years behind of their peers who normally hear in terms of language learning. In this period, a hearing impaired child does not know yet that everything has a name described by sounds.

Regardless of whether the child is healthy or hearing-impaired, the first four years of his/her life is considered to be a critical period in the acquisition of the speaking skills due to the changes and development of myelin envelope taking place in the neuronal pathways related to the hearing processes. In this critical period, it is necessary to make use of every type of external teaching activity that can help overcome the obstacles preventing the acquisition of speaking skill (Şerbetçioğlu, 2000; Downs 1999; Sininger 1999).

As a result, the oral education of preschool hearing impaired children is a very complicated process. The verbal education to be provided for the hearing impaired preschool children should include the processes to train the children in hearing, discriminating sounds, as well as teaching concept and acquiring the language.

Whenever a baby is diagnosed and he/she is cochlear implanted or fitted with hearing aid, auditory/oral education therapy starts. During oral training method, concept teaching steps for preschool children can be carried out as follows:

- The education of a hearing impaired child is initiated with a word. This initial word is called as "a key word" as well. The child builds all the words he/she will learn around this initial word. **Selection of the initial word:**
  - This initial word may be different for each child and determined depending on the interests of the child. It should be an object that would draw the attention of child (Anadolu Üniversitesi, 1996).
  - Initial word should be chosen among the names of the concrete objects as this will facilitate the conception of the word by the child. This should be an object easily displayable in the classroom. It is also useful to choose an object that can be widely encountered in the real world of the child. In this way, the concept to be taught can be frequently seen around and remembered and this provides many opportunities to pronounce the concept and consolidate its correct pronunciation. All these will help the retention of the concept (John Tracy Clinic, 1983).
- **Teaching the initial word** is very hard and demanding work for the teacher. The teacher has to repeat initial word as possible as could do, in different sentences in one session, not to expect any feedback. "It is observed in the records of a course where the tutor teaches to a hearing-impaired child that he/she repeats the word to be taught for

92 times in 5 minutes. If one word is repeated at least one hundred times in a day, same word has to be repeated nearly six thousand times in two months. (Anadolu Üniversitesi, 1996)."

- **The period of learning the initial word takes time**. Learning the initial word might take very long time as months and this time changes depending on the capacity of the child.
  - Two month is essential. Learning this initial word could take time as the multiplication of two or three times of two months (Anadolu Üniversitesi, 1996).
  - The initial world should be consistently repeated in the class and outside the class in natural conversations, but the child should not be forced to repeat the word. And while teaching new words in the future lesson to the child, he/she must be provided with opportunities to repeat the previously learned words. Otherwise, the initial world can easily be forgotten (Kılcıoğlu, 2004).
- During the oral education, the initial word must be used not on its own but within a sentence (M.E.B., 2003; Özbay, 2000).
- The method of word practice with the stories, or sentences is to take a short sentence or a complete clause if the sentence is long, and say the sentence, or clause as many times as there are word in it, each time concentrate on a different word, one word at a time. "The first time say the entire sentence, or clause, naturally, and concentrate on the first word, the second time on the second word, and so on (Nitchie, 2007)."The method of teaching initial words (Nitchie, 2007):
  - say the sentence, or clause as many times as there are word in it,
  - take a short sentence or a complete clause
  - say the entire sentence, or clause, naturally
- Same word has different meaning in different situations and also it is stressed differently in different position in the sentences. Pronouncing

the same word with different stresses and intonations to the child will help him/her to understand the word utterly (Akçamete, 2003). Examples:

- "Look at the ball"
- "Ball is here"
- "This is a ball"
- "Catch the ball"
- "Throw the ball to me"
- "This is a big ball"

4.1.2.1 Concept and Context Teaching Together in Hearing Impaired Education

What is important is that the child needs to learn how to use the concept within a sentence because; concepts are not used on their own but in sentences. The pronunciation of a concept on its own is different from its pronunciation within a sentence. For example: It does not mean much that the child pronounces the concept of "ball" on its own. If the concept is learned on its own, the child may not recognize it within a sentence. The child needs to hear the concept in a sentence and produce it in a sentence.

4.1.3 Third Component: Contextual Aspects

The contextual aspect of the speech is probably underestimated but one of the major sources of information. Same word might have different meaning in different situations (Şerbetçioğlu, 1998).

4.1.3.1 How Do Hearing Impaired Children Acquire Language?

There is not any difference between hearing children and hearing impaired children in terms of language acquisition.

"Deaf and hearing children go through similar stages of language development, although the age at which they progress trough these stages may vary (Stewart & Clarke, 2003)."

4.1.3.2 Building Language for Hearing

During concept teaching education of the hearing impaired children, absence of fifth sense of hearing has to be complemented through strengthening with other four senses, particularly the sense of seeing. In this respect, reading for these children has a role as hearing and as push repeatedly building language context.

The role of reading, in the beginning the history of hearing impairment's education remarkable. Geromino Carnado, an Italian Physician, recognize that learning does not require hearing. In the 1500s, he found that the hearing impaired could be educated by using the written word. He used his methods to teach his own deaf son (ASL.com, 2009).

Importance of reading and writing for building language context in the hearing impairment history is stated in Hellen Keller's life. Helen Keller is perilingual hearing impaired and also blind. She was born as a healthy person but she became deaf and blind after she had meningitis when she was 19 months old. She started her education when she was 6 years old. Her teacher gives the objects to her hand and write the spellings of objects in her hand. Hellen Keller communicates with the people by reading and writing by finger spelling. When she was ten years old, Hellen took also speaking lessons and learned to understand what someone else was saying by touching his/her lips and throat. In 1900, she entered a collage and graduated from Radcliffe Collage, earned Bachelor of Arts degree. She wrote her first book "The story of my life" which was published in 1903 (Bartoschek, 2006; Royal National Institute of Blind People, 2009).

4.1.3.3 Context Teaching

Recognition of a concept within a sentence is more difficult due to different intonation. Moreover, the meaning of the whole sentence where the concept occurs should be understood. In addition, it is not possible to explain the action expressed by the sentence in which the concept is used through theoretical training. The most difficult aspect of education the hearing impaired is to explain an action. It is difficult to explain it with only one picture. For example, how a teacher can explain the difference between the sentences "throw the ball" and "catch the ball" or "get into the car" and "get out of the car" with only one picture? Sequenced pictures are needed. For each activity, at least three sequenced pictures have to be shown or drawn in hearing impaired children's education.

In the advanced stages of the language acquisition of the hearing impaired, an important problem that can be confronted with is teaching tenses. It is very difficult to teach the difference among "he will come", "he is coming" and "he came" in theoretical lessons. Other concepts that can be difficult to teach in advanced levels are abstract concepts such as being happy, sad, angry etc.

4.1.4 Fourth Component: Auditory

Basic requirements of communication using spoken language are mainly depend on sounds related to spoken language. First of all, sounds of speech must be heard. These sounds ought to be discriminated and percepted as speech sounds. And finally speech signals should be comprehended with in the context. As a result of improvements in technology, it became possible to assess the hearing of children and fit wearable hearing aids. Further improvements to hearing aids (high-power aids as well as digital aids) and the advance of cochlear implants allowed greater numbers of young profoundly deaf children to assess spoken language through audition (Şerbetçioğlu, 1998).

4.1.4.1 Limitations of Hearing Aids

Hearing aids may become incapable in some situations as:

- Most of the time hearing aid can clarify only vowels with low frequency and high intensity but not consonants with high frequency and low intensity.
- If children start auditory stimulation after age 3, the process is progressively more difficult (i.e. late-diagnosed hearing impaired children)
- Profoundly hearing loss and non cochlear implantable children
- Hearing impaired children having additional disease for example: Meniere disease, fluctuations in the hearing thresholds
- Hearing impaired children having another handicapped such as spastic, down, autistic… (children have problem in receptive communication and additionally have problem in expressive communication). Children from whom feedback can be taken in a very long time and so effectiveness of the hearing aid is not known for sure.

The situations when hearing is reduced, visual perceiving increases (it naturally comes to fore). Therefore, naturally lipreading gains more importance. As a result, they began to hear with eyes.

How can these children hear by eye, if we represent auditory signal properties visually, they can easily perceive these signal outputs, and they learn how to sort out these signals, so they can use them in correcting their pronunciation.

4.2 AURIS: Computer Aided Education and Training Tool

AURIS, which is the computer aided tool combining both visual and audio technology; has been designed as an elementary supplement to strengthen the learning system and in a way that would support the education of hearing-impaired children.

AURIS, is implied with its ability to support individual characteristics of child that the personal particulars of child (including his/her mother, father, siblings and himself/herself) are recorded by means of the software during the application of pictures and they can be used again during the studies. Furthermore, the software is providing the opportunity to expand the software by including as much objects as desired for including the objects the child is interested in and even local or regional objects. For instance, it is possible to include a ship for a child interested in ships, or his/her favourite dish, for example Turkish pizza for the child interested in food, or an animal or person he/she loves, as an object in the selection of key words.

In this section the prototype of AURIS will be introduced.

4.2.1 AURIS Design Theory

Theory of Auditory/oral methodology is examined into four components in the previous section as:

- Lipreading
- Concept
- Language Context
- Auditory

Relationship of Auditory/oral methodology and the software design of AURIS is shown in the following pictures Figure 4.2, 4.3).

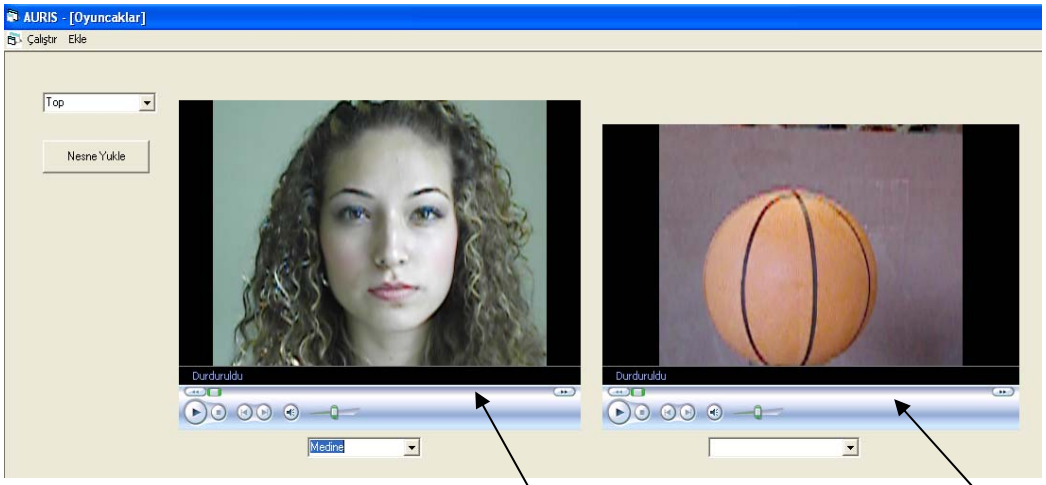

Figure 4.2 First and second components related to Lipreading and Concept

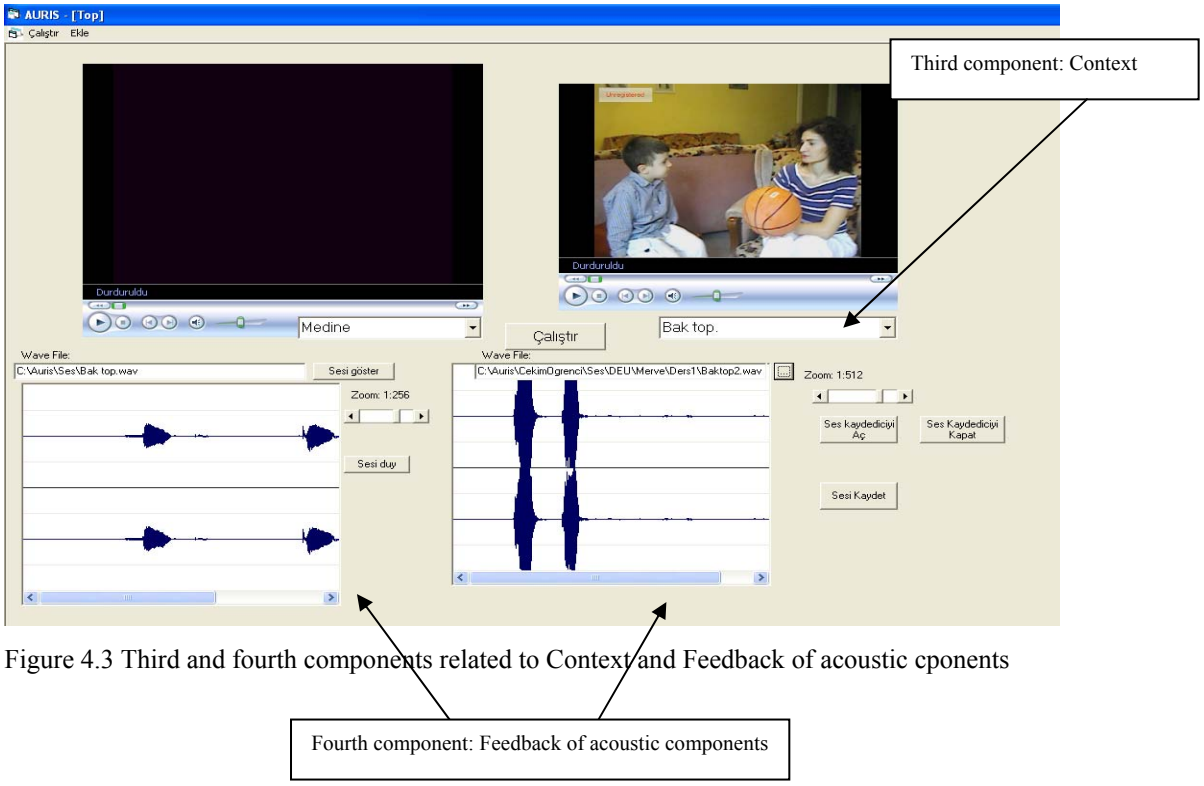

Figure 4.3 Third and fourth components related to Context and Feedback of acoustic cponents

4.2.1.1 First Component: Lipreading in AURIS

To review the role of lipreading in learning verbal communication, it could be looked over the figure 4.4 which the educational approaches is examined in chapter two. It can be seen from this figure, tendency to employ oral methods increases depending on child's hearing ability. If the child can benefit from

hearing devices more, preferable methods tends visual to auditory. With decreasing residual hearing, children need to use visual methods increasingly.

Consequently, children need lipreading depending on his/her residual hearing. If child's residual hearing is low, try to complement his/her hearing ability with visual elements and he/she will need lipreading more.

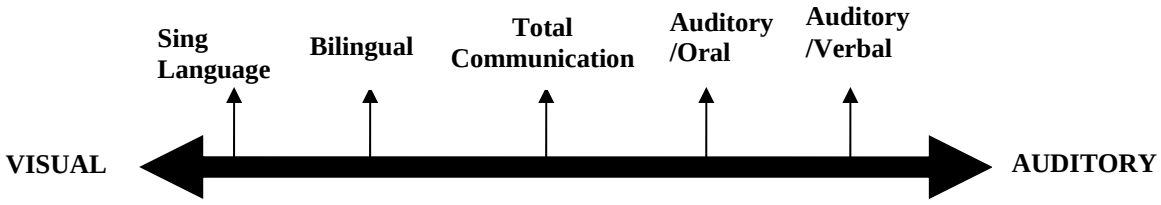

Figure 4.4 Educational approaches for hearing impaired (Şerbetçioğlu,1998)

So that lipreading is not the end purpose in AURIS. Lipreading is a supporting component in AURIS for the child to learn and develop verbal communication skills. While the child is training to learn the language by AURIS, he/she also learns how to make use of lipreading and consolidates lipreading skill.

Each speech sound (phoneme) has a particular facial and mouth position (viseme). Lipreading depends on these facial mimics. This viseme is changed for every one (has individual differences). So lipreading has to be a practice with the different face. AURIS's lipreading component is designed to allow to exercise same concept with different instructors Figure 4.5 and Figure 4.6.

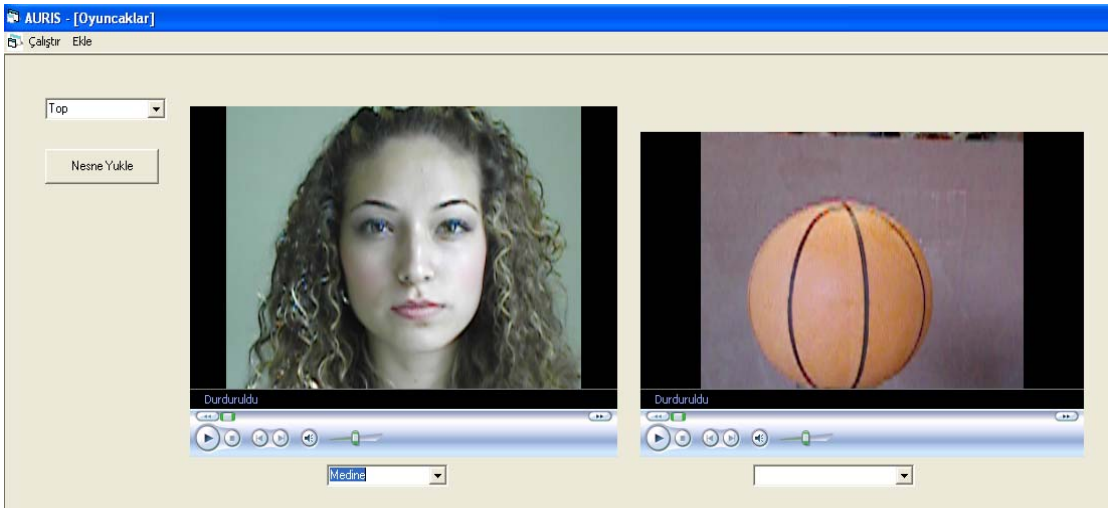

Figure 4.5 First instructor, teaching concept "Ball"

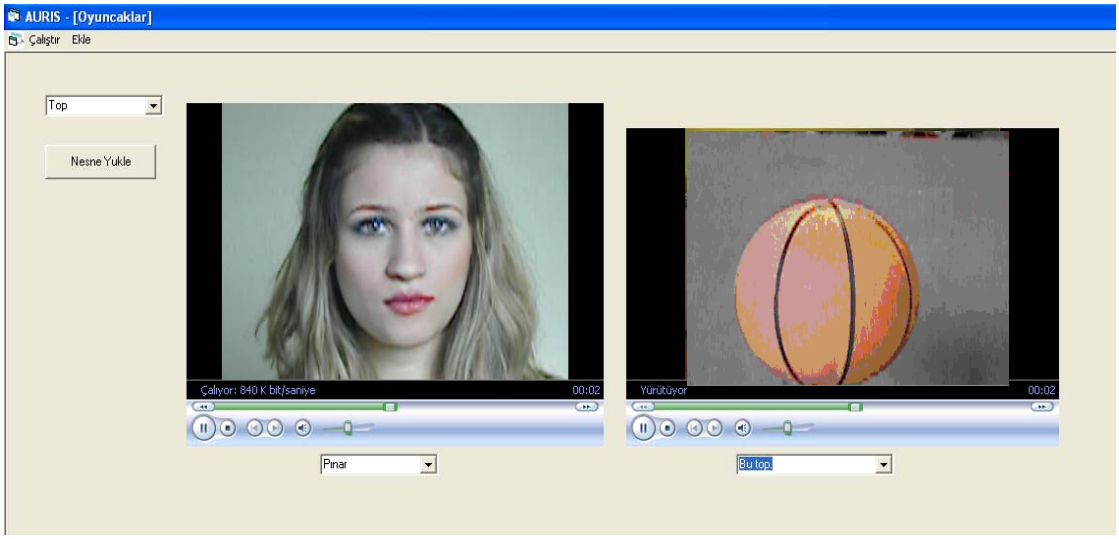

Figure 4.6 Second instructor, teaching concept "Ball"

4.2.1.2 Second Component: Concept Teaching by AURIS

AURIS is designed for teaching verbal communication of hearing impaired preschool children who do just start yet or even can not talk at all. The oral education of the hearing impaired preschool children starts with concept teaching. So that AURIS is designed as the education starting with the concept teaching as well.

Advantages of AURIS as a computer based instruction for concept teaching:

- During preschool hearing impaired children education, the main principle is to show the real model of the concept that is wanted to be taught. It is acceptable to show some concepts' model samples in the classroom as "ball", "car", "doll" which the real models have already been seen by them before. But there are some concepts whose models have not been seen by them yet and the real models can not be provided in the classroom such as plane, ship, train etc. Such models could be easily presented in many variations through computer. And these concepts can easily be added to the AURIS database.
- During concept teaching education of the hearing impaired children, absence of fifth sense of hearing has to be complemented through strengthening with other four senses, particularly the sense of seeing. In AURIS, first the chosen concept which is wanted to be taught is displayed on the screen, the written form of the concept is shown under the concept, additionally pronunciation of the concepts' is heard and consecutively video recording showing face image displaying lip movements is taken apart on the screen. In this way, children can see the concept, hear, and learn the pronunciation of it by lipreading and recognize the relationships of phoneme by seeing the letters. For example, a child who is pronouncing the word "ball" as "doll" is wanted to be taught the concept of "ball". This child either cannot hear the sound "b" or distinguish it. No matter what the reason is, one of the ways of correcting a phoneme that is not heard or erroneously pronounced is to show the difference between these phonemes. This difference can be eliminated by drawing the child's attention to the movement of the lips on the screen and also the teacher may do it by visually showing the spellings of the phonemes. Moreover, if the child pronounces "b" as "d", you immediately go on with the second concept "toy". In this case, the child can recognize the difference between "b" and "t" by reading the lips. In addition,

when the teacher draw the attention of the child to the spellings of the concepts, it will be easier for the child to recognize his/her mistake and try to pronounce them correctly. The difference among the pronunciations of the letters “b”, “d” or “t” could be perceived easily by a hearing impaired child who has naturally developed visual memory.

4.2.1.3 Third Component: Context Teaching by AURIS

Computer based instruction helps to overcome the difficulties in the education of context teaching for the hearing impaired children as follows:

It is not possible to explain the action expressed by the sentence in which the concept is used through theoretical training. The most difficult aspect of education the hearing impaired is to explain an action. While teaching how to use a concept in a sentence; that is, the grammar of the language, there is a need for pictures explaining the action including the concept. But, it is difficult to explain it with only one picture. For example, how a teacher can explain the difference between the sentences “throw the ball” and “catch the ball” or “get into the car” and “get out of the car” with only one picture?

The advantage of the computer based education over the traditional education comes into being at that point. Through the pictures or cartoons or video in the computer, teacher can easily explain the concept that he/she wants to teach.

In AURIS, the chosen concept which is wanted to be taught is displayed on the screen, then, the text of the alternative sentences is shown including the chosen concept. In the same time, the act of chosen sentence’s video displays are shown and the pronunciation of sentence’s face video recording including lipreading is taken apart on the screen.

4.2.1.3.1 Training Concept and Context by AURIS. Teacher and the child see a basic graphical user interface including, button to load concept and a combo box to select a concept. Child sees features of the selected concept as image and the lip motion.

First step: Concept is installed. If concept (initial word) is chosen as a "ball" from combo box, instructor and the ball images are displayed (Figure 4.7) on the screen.

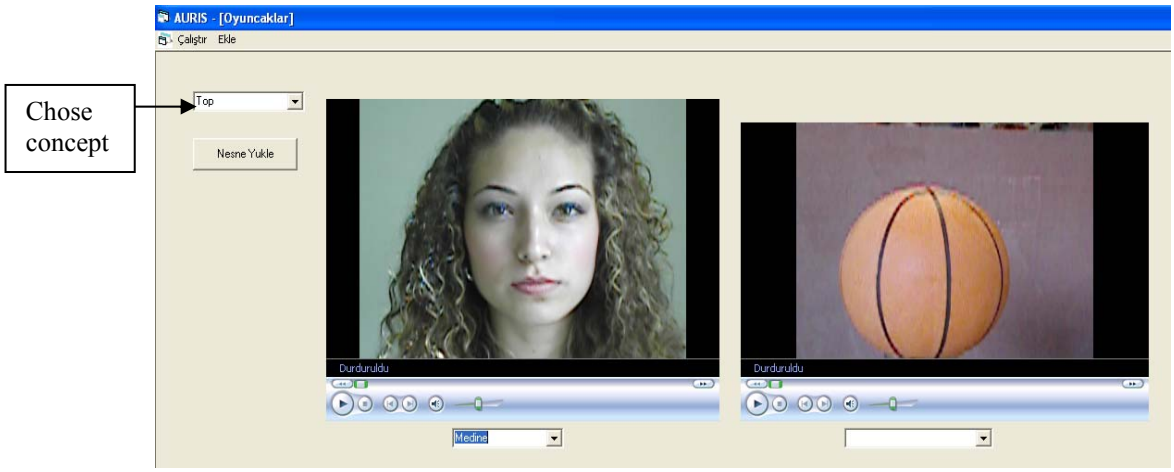

Figure 4.7 Teaching the concept "ball"

Second step: Sentences are chosen from combo box to consolidate the related concept in first step. AURIS's screen images is shown in Figure 4.8 which chosen sentence for "This is a ball".

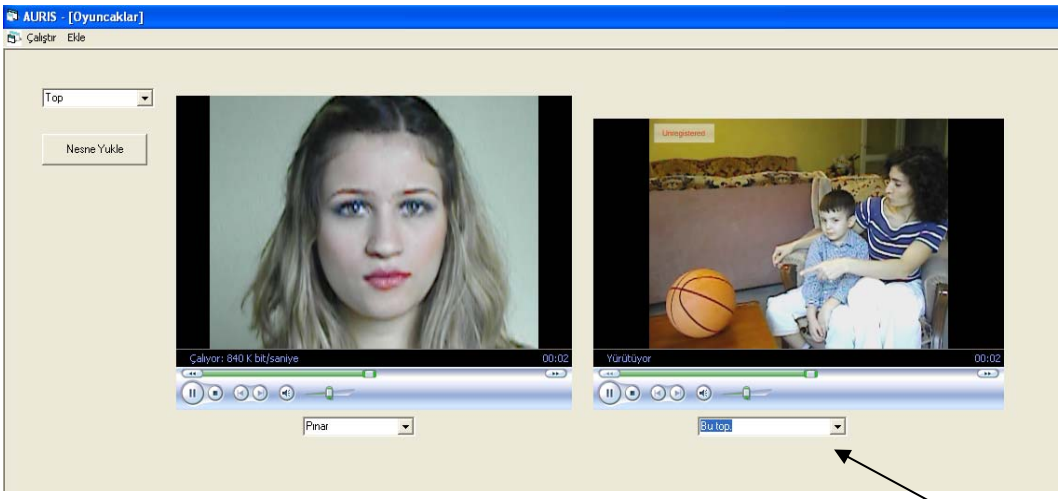

Figure 4.8 Training of the "ball" concept in sentence "This is a ball"

4.2.1.4 Fourth Component: Visual Audio Effects on Teaching Concept and Language Context

Through sound record software in AURIS, the children's voices are recorded during trainings. Then these recorded sound files are visually displayed. In this way, sound can be visually perceived by children. Through the sound graphics presented on the screen, children can recognize the unuttered syllabi, erroneous stresses, and the words not separated in the sentences. AURIS allow instructor to produce sounds correctly by showing sounds visually; the differences between the correct pronunciation and false pronunciation and the intonation differences in the sound unheard Figure 4.9 and Figure 4.10.

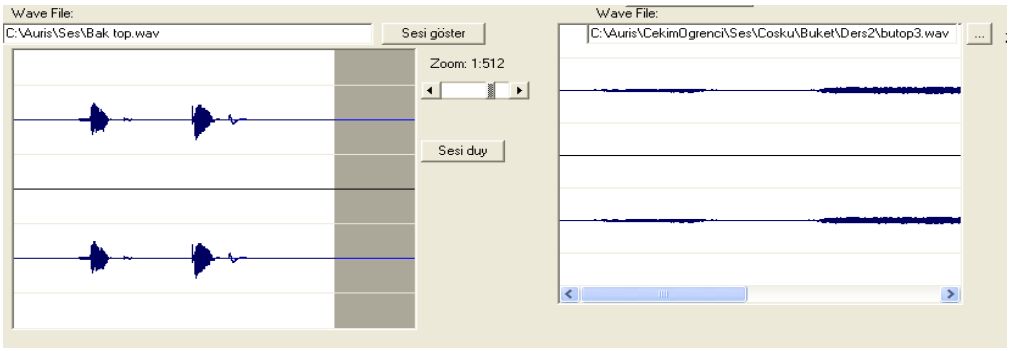

Figure 4.9 Articulation training (Sound graph of correct pronunciation in software on the left side-child's pronunciation in first session)

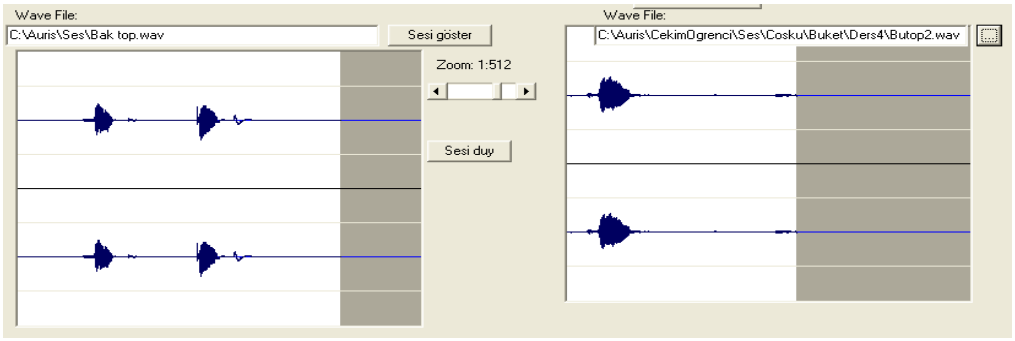

Figure 4.10 Articulation training (Sound graph of correct pronunciation in software on the left side child's pronunciation in last session)

4.2.2 Main Window

The main page of AURIS allows choosing topic for the advance lessons is shown in Figure 4.11.

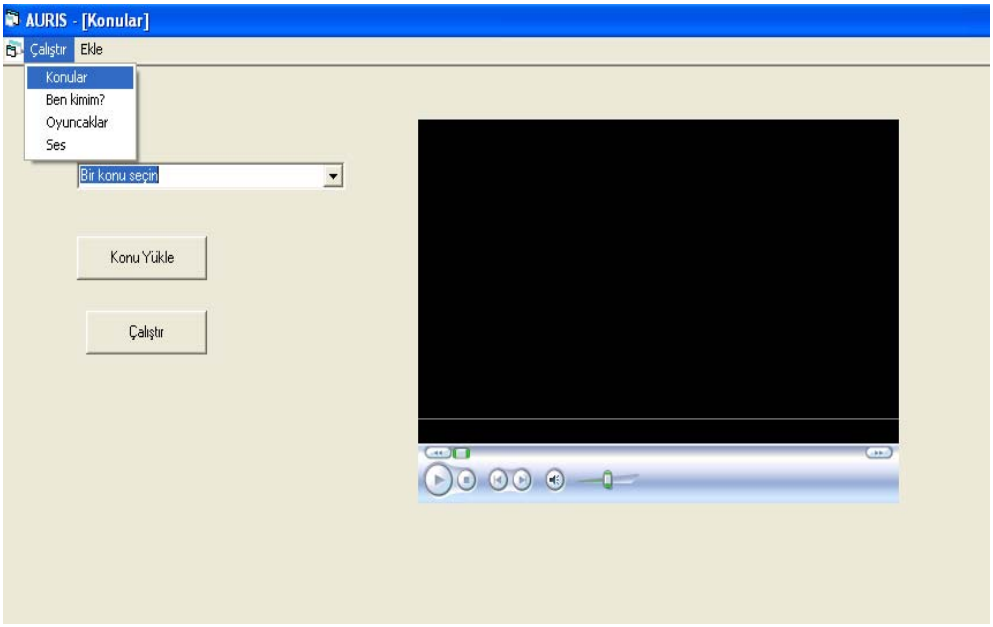

Figure 4.11 Main page of user interface

4.2.3 Adding Data to Database

AURIS allow user to add new data as Concept, Instructor and Sentences. Data are added to database by the “Add (Ekle)” menu command can be seen in Figure 4.12.

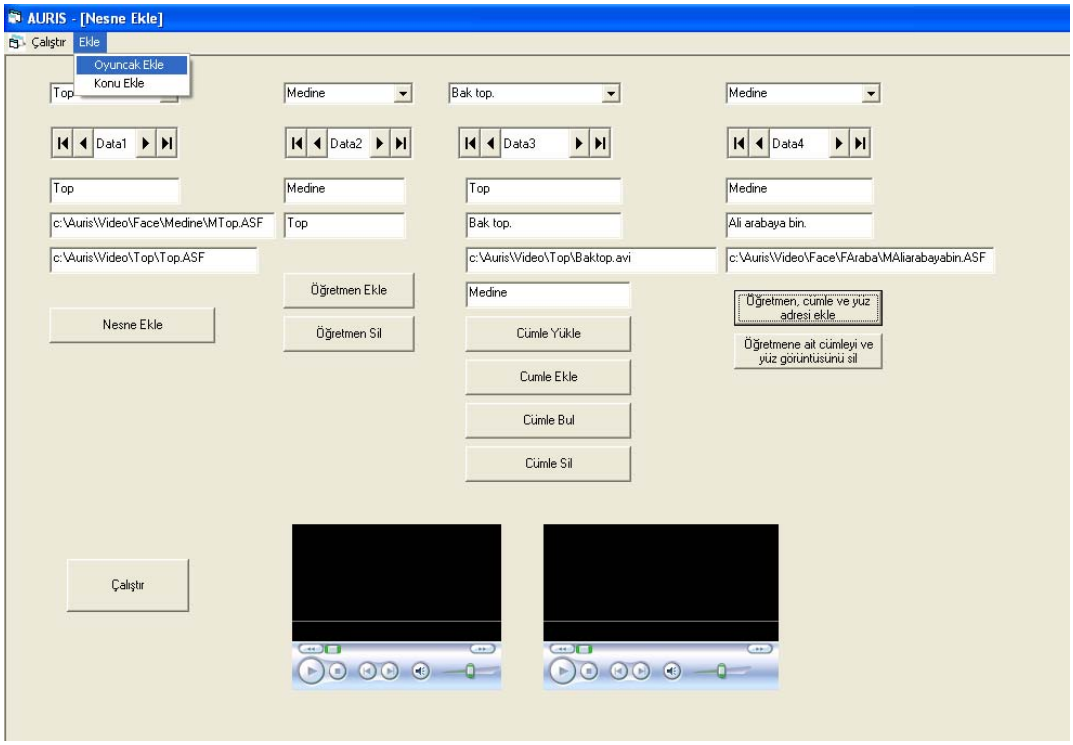

Figure 4.12 Adding “concept”, “instructor”, and “sentences” data to AURIS’s database.

AURIS also allow adding a new Topic to the database by the “Ekle/Konu ekle (Add/Add Subject)” menu command Figure 4.13.

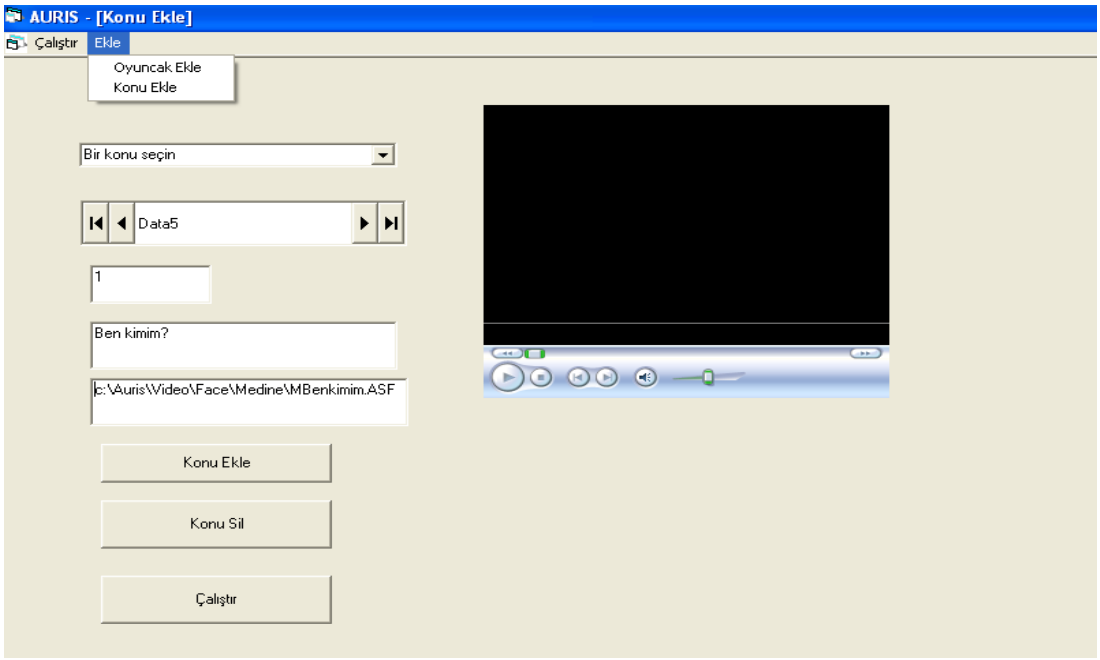

Figure 4.13 Adding “topic” as a new data to AURIS’s database.

4.2.4 Screen Image of The Subject "Who Am I?"

AURIS's main characters are introduced to the hearing impairment children by "Who am I?" screen (Figure 4.14). In this screen child's own photographs and family members' scanned photographs are loaded and saved to the folder by AURIS. Main aim in this page is integration of child to the software; provide to establish relationship between the characters of AURIS and himself/herself and his/her family members.

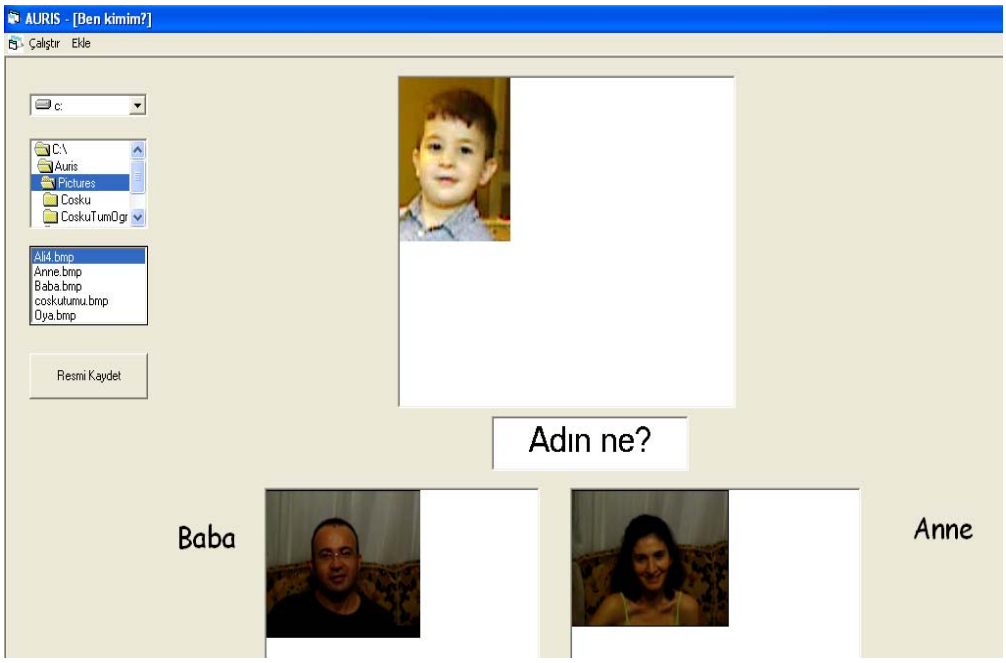

Figure 4.14 Screen shot of the subject "Who am I?"

4.2.5 Wave Viewer Screen

In the last step of AURIS for the auditory component is used Wave Viewer Screen. With the help of his part of the software, hearing impairment children's speaking and pronunciation problems is tried to be corrected. Children's sound is viewed by the help of voice analysis methods Figure 4.15.

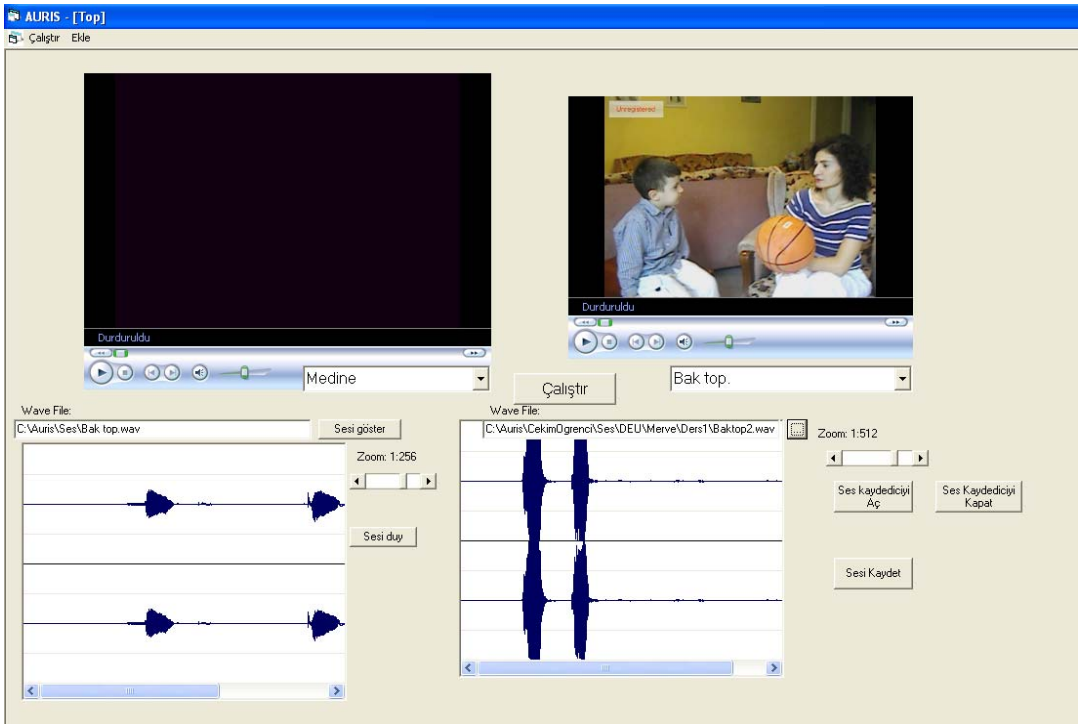

Figure 4.15 Voice training with the child

4.2.6 Voice Record Screen

Children's voice is recorded by following screen Figure 4.16.

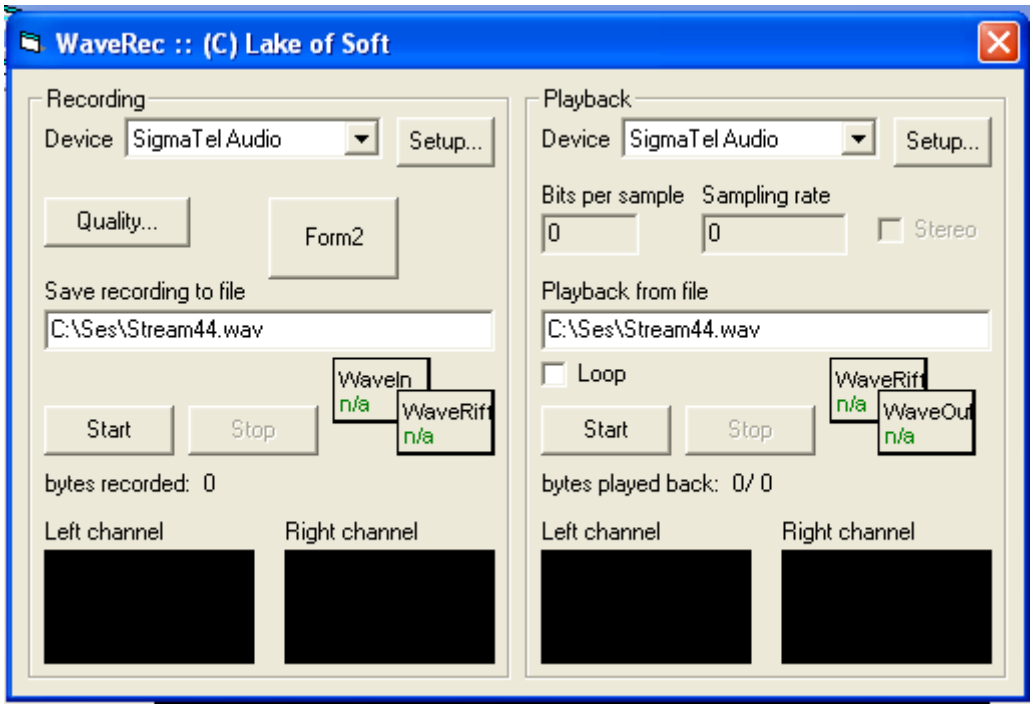

Figure 4.16 Screen shot for Voice Record (Shamray, 2008)

4.3 Software Specification

AURIS is implemented in Visual Basic 6.0 software development platform. The implemented prototype of software is designed for running on a single computer. Data are kept in MS 2003 database tables.

4.3.1 Diagram of Menu Items

AURIS's menu items are given as a diagram in following figure 4.17.

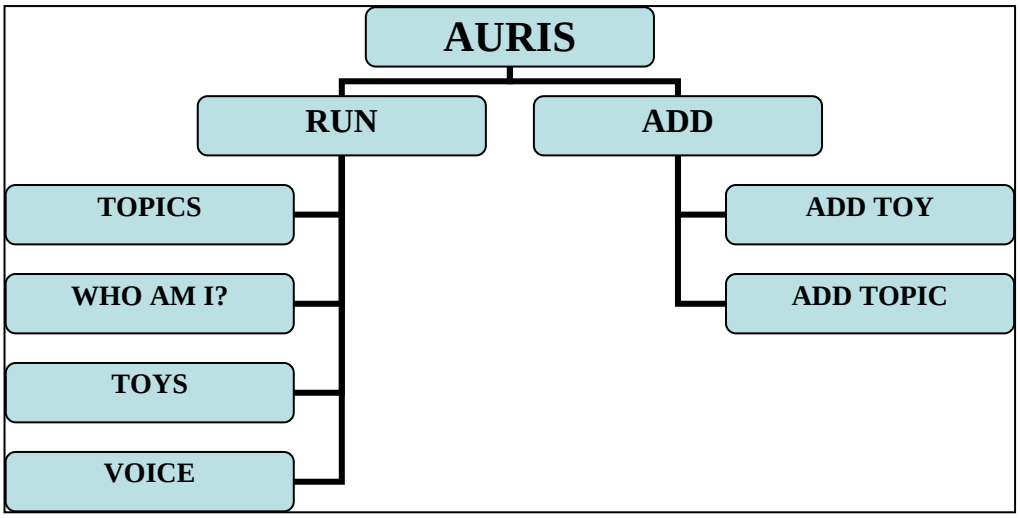

Figure 4.17 Diagram of menu items

4.3.2 Tasks of Menu Items

- RUN menu command (Çalıştır):
  - Topics:

    Input: When the Load topic button is pressed Topics are added to the drop down list.

    Output: A topic is chosen from the drop down list.

    Process: The Run button in this screen opens the window chosen topic.
  - Who am I? (Ben kimim?):

    Input: The photographs of the child and his/her family's are loaded from drive list box, directory list box, File list box

Output: Chosen photographs are shown in the picture boxes.

Process: New loaded photographs could be saved by the Save (Resmi kaydet).

- Toys (Oyuncaklar):

  Input: Load concept from database

  Output: The concept chosen from combo box

  Process: Run (çalıştır) button open window from the chosen concept

- Voice:

  Input: First the teacher and then the sentence is chosen from the com boxes

  Output: Wav file of the chosen sentence and the child' voice graphic are shown in the wave render boxes.

  Process: The child voice is recorded

- ADD Menu command (Ekle):
  - Add Toy:

    Input: A new concept, a new teacher, a new sentence and related lip reading video file are entered to the text boxes

    Output: The recorded files can be viewed and tested by the run button

    Process: Entered files are added to the database by the add commands.

  - Add Topic:

    Input: A new topic is entered to the text boxes

    Output: The recorded files can be viewed and tested by the run button

    Process: Entered topic is added to the database by the add commands.

4.3.3 Database Graph for Configuration Tables

In AURIS data are kept in database MS Access. Interface also allow to record a new data to the table in database. Relationship between Tables-Tuples is shown in figure 4.18.

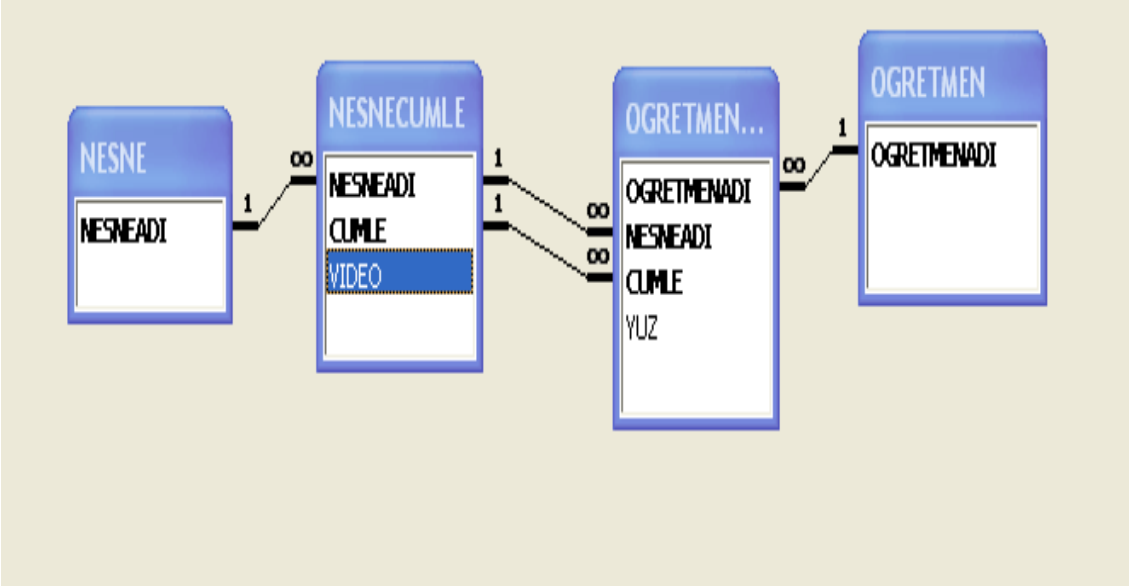

Figure 4.18 Tables in configuration database

Explanations of properties of tables are given bellow:

- Nesne (Concept): keeps the name of concept
- NesneCumle (ConceptSentence): keeps the sentences and action video recording path
- OgretmenCumle (InstructorSentence): keeps the instructor lipreading video recording path
- Ogretmen (Instructor): keeps the instructor name

CHAPTER FIVE
AURIS: CASE STUDY

As stated in chapter four, hearing impaired children and normal hearing children go through similar stages of language development. Furthermore, hearing impaired children's language acquisition is dependent upon several factors.

5.1 Critical Factors Effect: Language Development of the Hearing Impaired Children

Factors that are critical to the language development of all hearing impaired children includes the following (Stewart & Clarke, 2003; Şerbetçioğlu, 2006):

- **Degree of hearing loss:** Some hard of hearing impaired children (those who have a mild or moderate hearing loss) may receive sufficient gain from hearing aids that they are able to acquire a spoken language. But there is no guarantee that all hard of hearing children, even with hearing aids, will be able to adequately process sufficient speech sounds to become fluent users of a spoken language in a timely manner. Unfortunately, there is no way that can be predicted with any degree of accuracy which severe or profoundly deaf children will learn a spoken language through the use of amplified sound. With the help of hearing aids, some deaf children will benefit a great deal from amplified sounds, some will hear very little or nothing at all, and the remainder will fall somewhere in between.
- **Age of onset of hearing impairment:** Prelingual, perilingual or postlingual hearing impaired children will have a different task in learning a spoken language.

- **Etiology:** Some causes of deafness may lead to neurological damage or the presence of other disabilities.
- **Time at diagnosis of hearing loss:** Babies whose hearing loss is identified at an early age generally go on learning language better than those who are diagnosed later. An early start also enables parents to create a home environment conducive to language learning.
- **Ability of parent and child to communicate with each other:** What ever method of communication is used by the parents and child, it must be effective.
- **Hearing status of parents:** Hearing parents usually learn toward using speech as their primary means of communication with a hearing impaired child, whereas deaf parents are typically far more comfortable with signing.
- **Parental acceptance of child's hearing impairment:** Parents who accept their child's deafness more readily proceed with the task of raising the child than parents who are tended to deny their child's hearing loss or who refuse to make accommodations for their child in matters such as method of communication or need for visual information.
- **Education and Instructor:** The skill and knowledge level of the educator and the educator's dialogue with the child and guidance to the family are the factors affecting the achievement of the student.

Given these foregoing factors and more, hearing impaired child's learning language success should be determined according to their different abilities, attitudes, strengths, and weaknesses. Therefore, AURIS was applied to hearing impaired children as a case study.

5.2 Auris: Case Study

In the education of the hearing impaired children, auditory rehabilitation process is not a standard programme and furthermore, it is ought to be a "custom-tailored programme" (Serbetçioğlu, 1998). No two studies examined the same dimension of

literacy (e.g., reading comprehension, vocabulary, word recognition, writing (Luckner, Sebald, Cooney, Young & Muir, 2006).

In the light of these information's, AURIS was applied to the children as a case study. Theory of the case study design for AURIS is adapted from (Yin, 2009) Single Model Embedded, Multiple Unit of Analysis. Because AURIS consists of four components and these components can be adjusted according to child's interest, ability, and hearing capability etc. For educational research, ABAB model is applied (İftar & Tekin, 1997; Balcı 2004).

5.2.1 Participants: Setting Of the Study Group

For the purpose of determining the participants of the study group, the children in the age group of 2 to 8 years were screened. First, the reports issued by hospitals and results of the tests evaluating the extent of the loss of hearing sense were obtained. Through these reports, the extent of the hearing loss and whether the children were exposed to cochlear implant operation were determined.

Counsellor's Evaluations: All participants were tested and reported by specialists in regard to their intelligence and language development in Consoling Research Centre Then, the reports leading these children to special education from the rehabilitation centres were examined. The reports were analysed by us to see whether, apart from the hearing impairment, the children have other handicaps such as mental retardation, poor eyesight, spastics. The features of the children according to these reports are given in Table 5.1.

Table 5.1 Properties of Hearing Impaired Children

Number	**Child**	**Age of Child**	**Degree of Hearing Loss**		**Year implanted**	**Additional Handicap**
			Left	**Right**		
1	S.Y.	3,4	Total	Total	2007	-
2	İ.D.	3.5	Total	Total	2007	-
3	B.Ö	4,5	Total	Total	2006	-
4	Y.K	4,7	Total	Total	2006	-
5	E.A	5,7	Total	Total	Hearing Aids	Spastic
6	B.D	8	Total	Total	Hearing Aids	
7	D.K.	7	Total	Total	2007	
8	H.D.	3	Total	Total	Hearing Aids	Microsafali
9	Erenca n	2	Total	Total	Hearing Aids	
10	Nehir Abaka han	2	Total	Total	2007	
11	Ali Haydar Öztürk	7	Total	Total	Hearing Aids	Hyperactivity

Some of the children were eliminated due to reasons summarized bellow:

The participants of the study group were limited to preschool children in 2-6 age group. B.D., D.K. and A.H. were discarded from the group as they are older than 6 years old. H.D was excluded from the group as the parents could not afford to buy the hearing aid. During the studies H.D. could start doing the lip movements but she could not produce any sound as she could not hear. Because of the education depends on residual hearing she could not be included in study group. E.C. and N.A. -2 years old- could not attend the classroom on their own but with their mothers and they were afraid as their mothers would leave and cried all the time and could not concentrate on anything. They should be trained first in the rehabilitation centre in such a way as to attend the class independent of their mothers. Then, they can be included in the study group. The chosen children for case study are shown in Table 5.2.

Table 5.2 Properties of hearing impaired children

Number	Child	Age of Child	Degree of Hearing Loss		Year implanted	Additional Handicap	Date of hearing loss is fixed
			Left	Right			
1	S.Y.	3,4	Total	Total	2007	-	1,5 year
2	İ.D.	3.5	Total	Total	2007	-	1 year
3	B.Ö	4,5	Total	Total	2006	-	7 months
4	Y.K	4,7	Total	Total	2006	-	2 months
5	E.A	5,7	Total	Total	Hearing Aid	Spastic	11 months

In the study group (see Table 5.2), 4 of the participants had cochlear implants and had no other disabilities. The fifth patient is spastic and was fitted with hearing aid. None of these patients have not any mental disorder. All these participants were behind their peers in terms of language abilities, because of their hearing impairments.

5.2.2 Assessments

Before the case study, the children were assessed with regards to their auditory, language and educational levels.

5.2.2.1 Hearing and Language Level of Children

Children auditory and language level is assessed using Prelingual Language Scale-4 (PLS-4). PLS-4 is a standardized assessment of language for children between ages 0-6. It consists of two main subclasses: Receptive comprehension and Expressive communication. The children's test results of PLS-4 are shown (Table 5.3).

Table 5.3 PLS-4 test results of hearing impaired children

Number	**Child**	**Age of Child**	**PLS-4**	
			Receptive Language age (in months)	**Expressive Language age** (in months)
1	S.Y.	3,4	6-8	6-8
2	İ.D.	3.5	1,6	1,5
3	B.Ö	4,5	3,6	2,5
4	Y.K	4,7	2,5	2
5	E.A	5,7	5,0	3,6

When these two tables are examined, we can see the general overview of children's auditory features. All participants in the study group have total hearing loss and 4 of them are cochlear implanted one year ago, one of them is using hearing aids. And all the children's hearing loss was diagnosed when they were young. The language developments of children were measured by PLS-4 test. But, the results show that all children's language development is behind their hearing peers. The amount of this regression is at least 2 years behind then their peers. As the child grows older, the gap between their healthy peers increases more and more.

5.2.2.2 Education Status of Children and Their Families

In order to have a more realistic opinion regarding the level of the achievement a child can reach, the educational status of the families are also investigated. The parents of the participants hear as normal individuals. They communicate with their children orally. In the rehabilitation centre the children attending natural auditory oral method is being used. Information about the educational status of the children and their families is shown Table 5.4.

The characteristics presented in the three tables (Table 5.2, 5.3, 5.4) include the factors that can affect the children's achievement: hearing loss, level of language development, the time they started education. The data presented in Table 5.4 concerning the education level of the parents can be indicators for the academic achievement of the children. Due to genetic characteristics, the achievement level of the children is determined by the academic achievement of

the parents. This is an indicator of not only academic achievement but also intelligence. It is highly possible for children to have difficulties in language acquisition if their parents have difficulties in reading-writing and learning the language.

Table 5.4 Education status of the children and their families

Number	Child	Age of Child	Education Level of Families		How long has He/she been attending the educarion at the rehebilatin centre	How often do they have education at rehabilitation centre
			Father	Mother		
1	S.Y.	3,4	High School	Primary School	For 2 years	Three times a week, 3 sessions
2	İ.D.	3.5	Primary School	Primary School	For 2 weeks	Once a weak two sessions
3	B.Ö	4,5	Primary School	Primary School	For 1 year	Three times a week 1 session
4	Y.K	4,7	Primary School	Primary School	For 1 year	Once a week 3 sessions
5	E.A	5,7	Primary School	Primary School	For 3 years	Once a week 3 sessions

5.2.3 Applications

Proficiency test was given in order to learn the children's level for the case study. The session in which the child appropriatiness is measured for the case study and the training with the computers is mentioned Initial Evaluation Session.

Initial Evaluation Sessions: The children's knowledge about the concepts of the receptive and expressive language level is measured and scored about the concept which is taught by AURIS according to following properties:

- Ability to study with the computer is tested
- Total Word and sentence that can be heard,
- Total Word and sentence that can be pronounced,
- The level of pronunciation

A study programme was developed according to children's levels in initial evaluation session (Appendix A). According to this programme, theoretical and practical sessions were carried out. These sessions are evaluated in to four sections.

Sections 1, 2, 3, 4: Each Section consisted of 20 minutes theoretical and 20 minutes practical sessions. Total of 8 sections were carried out. In theoretical sessions, the same subjects were practised. In practical sessions, computer based education and training was carried out by AURIS.

5.2.4 Evaluation of Application

In all the sessions, each child's session was recorded by video. Their voices were also recorded with a microphone in first and fourth steps. These video recordings were evaluated to determine the success. Their achievement scores, video recordings and voice recordings were analyzed according to the points (Appendix B).

The scores related with these points presented in the table in order to inform the readers about the conceptual knowledge and pronunciation level of the case study participants. The child's score showing his/her ability to learn a new concept and how he/she pronounced it was calculated. The session and the minute he/she was able to hear and pronounce the phoneme, the word and the sentence showed his/her abilities and affected his/her score. For the results, a report card for each participant is prepared. The scoring in the report card is presented in Appendix C. The children's success determined and explained one by one.

5.2.4.1 First Participant: S.Y.

S.Y. is the youngest participant in the investigation group. Language development is the lowest (Receptive and Expressive communication level) as only 6-8 months. Cochlear implanted just one year before the case study applications but S.Y. did not produce any words.

S.Y. could not tell any words in the initial session and give not any feed back or reaction in the study. Because of not any feed back is taken from S.Y., she was subjected to hearing test again, but her hearing ability result was good enough. Surprisingly in the second session, she started to utter two-word sentences including the initial word. In the fourth session, she started to produce three-word sentences. While she could not produce any initial words in the first session, in the fourth session, she was able to distinguish “ball”, “Ali”, “Oya” included in these sentences “This is a ball”, “Ali, throw the ball”, “Oya, throw the ball”, “Oya, catch the ball”. She managed to get 10 points by pronouncing the words correctly (Table 5.5). This is the AURIS’s success for a child attending education in rehabilitation centre for two years but does not say any words before. In the computer instructional environment, she started to say initial words in the second sessions and understand them in sentences and tried to use them in sentence in the follow-up sessions in a short time.

Table 5.5 The results of first participant

Session	**Number of Studied Sentence with 1 word**	**Number of Studied Sentence with 2 words**	**Number of Studied Sentence with 3 words**	**Maxim point in one session**	**How many 10 point**
İnitial Session	0	0	0	0	0
Session1	12	0	0	3	0
Session2	13	2	0	8	0
Session3	11	3	0	8	0
Session4	10	3	3	10	2

5.2.4.2 Second Participant: İ.D.

During the initial session, it was found that İ.D. was not able to say any word except for the word “father”. While İ.D. could not tell any words in the initial session, she started to understand and tell the initial words, within two sessions, she managed to tell the world “ball” and got 8 points. Moreover, in the third and fourth sessions, she learned the second initial world “car” and started to

pronounce it. Such a result -learning two initial words- in such a short time is the indication of a great success for this child.

Besides, when she is compared to other children in study group, she is not successful yet in two-word sentences. The reason may be her having a hearing impaired elder sister and poor oral communication environment in the family. Moreover, while the other children have been trained at least for one year, İ.D. started her training in the rehabilitation centre just two weeks ago. In addition, the number of the sessions she participated is fewer and irregular.

In spite of all these negative factors, AURIS proves its contribution in a computer aided education to the education of a child who has not talked yet, has never had education before and exposed to very few stimuli encouraging her to speak in the family environment (Table 5.6).

Table 5.6 The results of second participant

Session	**Number of Studied Sentence with 1 word**	**Number of Studied Sentence with 2 words**	**Number of Studied Sentence with 3 words**	**Maxim point in one session**
İnitial Session	0	0	0	
Session1	15	0	0	8
Session2	7	0	0	4
Session3	11	2	1	4
Session4	6	0	0	4

5.2.4.3 Third Participant: B.Ö.

She was the student with the best initial capacity in the study group. She knew the three initial words but could not pronounce them correctly. Initially, while he was calling “top” as “pop”, then with the correct pronunciation of it, she managed to get 10 points. In the third and fourth sessions, she managed to get 10 points by telling the sentences including initial words as “It is a ball” and “This is a car” correctly. She was able to use the concept in a sentence correctly and pronounce

correctly through practice. When she heard the sentence “This is a ball”, she could not understand “this” and hence got bored and he changed the sentence into a new one “this is a car”, and then she could hear and pronounce it correctly. This supports our assumption. Using the same word together with different words in the sentence enables her to correctly understand, hear and pronounce. This proves the hypothesis is claimed in this thesis that working with sentences makes the learning of objects longer lasting and more effective (Table 5.7).

Table 5.7 The results of third participant

Session	**Number of Studied Sentence with 1 word**	**Number of Studied Sentence with 2 words**	**Number of Studied Sentence with 3 words**	**Maxim point in one session**	**How many 10 point**
İnitial Session	3	0	0	4	0
Session1	7	2	0	4	0
Session2	7	2	0	8	0
Session3	2	1	2	10	1
Session4	1	4	1	10	2

5.2.4.4 Forth Participant: Y.K.

Y.K. is a student making great progress in pronunciation. When the studies in the first sessions are repeated in order to measure success of student, it was realized that she was repeating what she had been told very well but she was imitating the words without perceiving their meanings. It was just the repetition of the sound without grasping the meaning.The conception seemed to be retarded. When the reasons evaluated, it is considered that mother can not tell the age of her child from the memory. The fact may conclude that there is genetic basis of this retardation. Another fact may occur of her attendance to the training once in a week and the irregularity of this attendance may result from the lack of support provided by the family for the training. The drawbacks of the family’s failure to bring the child to the session could have caused the decrease of the achievement scores. Maybe (Y.K)’ failure is because of these breaks in studies. (Table 5.8).

Table 5.8 The results of fourth participant

Session	Number of Studied Sentence with 1 word	Number of Studied Sentence with 2 words	Number of Studied Sentence with 3 words	Maxim point in one session	How many 8 points	How many 9 points	How many 10 points
İnitial Session	3	0	0	0	0	0	0
Session1	15	0	0	10	0	0	1
Session2	3	2	4	8	2	0	0
Session3	13	2	2	10	1	1	2
Session4	9	0	2	10	0	2	5

5.2.4.5 Fifth Participant: E.A.

E.A. was the student who was regarded as the worst student in the study group. Moreover, he is spastics. Hence, he was not implanted and using a hearing aid. As he was spastics, except for restricted painting, he was not encouraged to perform any activities such as concept teaching or language acquisition. He is the oldest among the children.

At the beginning of the case study, he was thought to be discarded from the study but when the evaluation session started, it was realised that E.A. already knew the initial words.

He/she only had difficulty in their pronunciations. It was meausered that in the second session, he managed to hear, understand and pronounce two-word sentence and in the third session, three-word sentence, even he was able to tell his mother:

- Mommy she is saying ‘Ali, throw the ball’,

and he used the program on his own and work with the sentences such as “throw the ball”, “look at the ball” without the guidance of the instructor (Table 5.9).

The greatest success achieved by AURIS with this participant is revealing that “E.A”, who had been thought of having mental deficiency because of being spastic in addition to his/her hearing impairment and left aside, was in fact very

clever; he/she could hear very comfortably despite of his/her total hearing loss diagnosis; he/she could understand what's said without lipreading; and the things he/she learned were permanent. These were reported to his/her instructors. While they hesitated in sending him/her to elementary school although he/she was at primary school age. , this time it was revealed that he/she might be much more successful in other children in the study group if given very intense weight to his/her education and that he/she may attend orientation program at the public school.

Table 5.9 The results of fift participant

Session	Number of Studied Sentence with 1 word	Number of Studied Sentence with 2 words	Number of Studied Sentence with 3 words	Maxim point in one session	How many 8 points	How many 9 points	How many 10 points
İnitial Session	9	0	0	4	0	0	0
Session1	8	4	0	7	0	0	0
Session2	4	3	6	8	1	0	0
Session3	1	1	0	10	0	0	2
Session4	0	0	2	9	0	1	0

5.3 General Evaluation of Success of Case Study

When all the results are evaluated together, within the context of the education program carried out with AURIS, following can be claimed:

- Two participants (S.Y) and (İ.D), unable to sound any meaningful words and who did not start talking at all, succeeded in learning at least two concepts in such a period of two months; it was ensured that they perceived such words while using in sentences and even they used them in sentences.

- The participant (B.Ö.) was the best level in the study group, was knowing the initial words, was enabled to perceive pronunciation mistakes and correct them. It was contributed in correcting his/her pronunciation by AURIS.

- The AURIS revealed that (Y.K), the participant who was initially able to pronounce three-word sentence was found to in reality be repeating the words without knowing their meanings, and to have a retardation of conception.

- The AURIS assisted in determining that (E.A.), the student who had been thought of having mental deficiency, was in fact more successful than all the others in hearing, perceiving and speaking.

5.4 Results

The success of AURIS as a computer aided instructional tool is examined under four categories in further detail:

- Teaching a Concept
- Teaching in a short Time, Easily and Enjoyable
- Answering Orally and Improving Pronunciation
- Retention

5.4.1 Teaching a Concept

At the beginning of the study in the evaluation session, the participants' knowledge of the initial words is tested. Three of them did not know the target concepts; and could not answer the question "What is this". They learnt these concepts after two or three sessions. For example; (Y.K.), (İ.K.), (S.Y.) were able to give us the ball when we asked "Give the ball" choosing the correct object out of three.

5.4.2 In a Short Time, Easily and Enjoyable

The children reached the targets in a comparatively shorter period, achieved concepts more quickly with the help of moving images and visual effects compared to the theoretical lessons.

AURIS, in teaching the key word to three hearing impaired children who can not communicate verbally (did not even make sounds as cooing) was successfull. Teaching only one initial word could take months in classic education but in our study group children succeeded to learn at least one initial word within only 2 sessions in 2 weeks without being tired and bored at all.

5.4.3 Answering Orally and Improving Pronunciation

After they began to pronounce key words, we tried to improve their speaking and pronunciation problems with the help of AURIS voice analysis method. In the final session, they were able to pronounce the concepts correctly. When the question "What is this?" is asked them in the last session, they were able to answer as "ball", "car", and "doll".

5.4.4 Retention

Children do not forget the key words they have learnt in first sessions. In the further studies with AURIS, they also began to understand the meaning of the sentences including these key words. They were able to hear and distinguish the concept (key words) within the sentence, and also comprehend the meaning of it "Throw the ball" "Hold the ball" "Ali, throw the ball" "Throw the ball to your mother". They could even comprehend three word sentences as well as able to make meaningful sentences. As a conclusion, teaching a concept with AURIS is proved to be effective.

5.5 General Evaluation Success of AURIS

These results prove that AURIS can be used as an instructional tool for hearing impaired preschool children at all levels regardless of the age, level of conception, intelligence and hearing capacity in oral education.

Finally, it is necessary to emphasise that the achievement that the students have obtained is just the beginning of the road they should pass. The present case study shows what these children can achieve. The studies must be continued this way throughout their education life. All such concepts that they learn with such a difficult and intense study would be forgotten if not repeated and studied for two, even one week since the audio inputs are less. The new information should be built on this former information. They must continue receiving such intense education continuously and regularly in order that they cover a distance in their education life.

5.6 Limitations of Case Study

Limitations of case study can be summarized as follows:

- Not searching the language and intelligence level of relatives in addition to the education status of families
- Grading the scores by more than one specialist, and evaluating the average of such points
- Not testing the applications through the software in addition to analyzing and evaluating the video records of applications.
- Interruption between the sessions because of illnesses and the family’s failure

CHAPTER SIX
CONCLUSION

With the successful cochlear implant operations, currently hearing losses are no longer result in an individual's isolation from the society. Even when the children with a congenital hearing loss have a cochlear implant, their brain's perception of the sound is not natural as normal hearing children. Children with profound and severe hearing loss should receive a comprehensive education during the preschool period. When this period is overlooked, individuals' natural hearing and communicating opportunity will also be missed and the child with a hearing impaired will fall far behind his/her peers. This retardation will be impossible to compensate afterwards. Everybody appreciates the importance of this critical period however, this education is too hard, tiring and requires a long time. The child needs an individually tailored education in preschool period, and also an interaction with his normally hearing peers in kindergarten. In these situations, the cooperation among family, teachers and school is of great importance. The starting point of this thesis is to develop a computer aided tool that could help the education of hearing impaired children.

When the software and scientific papers published in the international literature were investigated, some computerized lipreading assessment and training systems for English language were found. However, when these tools are examined, basically all these tools have been developed with the commercial concern in mind. In the national literature, there are some computerized studies of sign language but there is no computerized lipreading system designed for hearing impaired children.

With the computer aided instructional tool, AURIS, it is aimed to lessen the hardships and struggle that children and educators experience during education. AURIS has been designed as an elementary supplement to strengthen the learning system and in a way that would support the education of hearing impaired children.

Case study results prove that with the support of AURIS, hearing impaired children can learn concepts and actions quickly with the help of moving images and visual effects. Hearing impaired children could even comprehend three word

sentences and improve their speaking and pronunciation skills with the help of voice analysis methods using AURIS. Furthermore, this kind of learning is more enjoyable and long lasting.

The results of this thesis show what these children can achieve the targets with the support of a computer aided tool. As a last word, it is necessary to emphasise that the achievement that the students have obtained with the support of AURIS is just the beginning of the road they should pass. AURIS is designed only as a prototype. This software should develop professionally for different educational stages of hearing impaired children.

By the lights of achievig goals in this thesis, greatest future target is to turn it into professional software. Further works to design includes the subjects

- the success of student can be tested through the software;
- the students can use it on their own;
- further level stages of the training section prepared for the 1st level will be will be prepared (abstract concepts, tenses).

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APPENDICES

Appendix A

The Steps of AURIS Study Plan:

Step 1: We test whether he/she knows the concept either by showing the original object itself or its toy model

1.a. He/she is asked to answer the question "What is this?" if he can not answer this, step 1.b. is applied.

1.b. He/she should answer "Which one is the ball?" "Show the ball"

Step 2: He/she must be able to name the word when asked with picture cards. If the child was able to match the two dimensional image of the word and the object itself, the computer study started. If the child failed to match the object and its image, theoretical education continued until he/she learn one of the target concepts.

Step 3: If he/she completes 1st and 2nd steps, he/she starts to study with computer.

Can he/she identify the concepts shown or spoken in AURIS software programme?

Can he/she understand the concept when pronounced as a single word?

Can he/she understand the concept when it is used in a sentence with two words?

Can he/she understand the concept when it is used in a sentence with three words?

Step 4: His/her ability to pronounce the concept

Can he/she understand and repeat the concepts when spoken in Auris software programme on computer?

Can he/she pronounce the concept when it is spoken as a single word?

Can he/she pronounce the concept when it is used in a sentence with 2 words?

Can he/she pronounce the concept when it is used in a sentence with 3 words?

Appendix B

Points related criteria:

Poit	Criteria
0	He/she listens to the questions but does not answer back
1	He/she does not know the concept and can't pronounce it
2	He/she does not know the concept but he can pronounce it
3	He/she can show the concept matching it with its counter part but he can't pronounce it
4	He/she pronounces one letter of a word incorrectly
5	He/she pronounces 1 word of a 2 word sentence
6	He/she pronounces 1 word of a 3 word sentence. (he can understand only one word) for example : "Ali throw the ball" sometimes "Ali" sometimes "the ball" sometimes "throw"
7	He/she can pronounce 2 words of a 3 word sentence. For example: "Ali, throw the ball" Sometimes "throw the ball" sometimes "Ali ball" sometimes" Ali throw"
7.5	He/she pronounces 3 words of a 3 word sentence but it is meaningless. For example: "Ali, throw the ball" is repeated as "throw Ali throw"
8	He/she makes stress (emphasis) mistakes
9	He/she makes grammar mistakes
10	He/she knows the concept and pronounces it right

Appendix C: Accivements Scores Of Each Child

Student Number	Session	TopA1a	ArabaA1a	BebekA1a	TopB1	ArabaB1	BebekB1	TopA2	ArabaA2	BebekA2	TopB2	ArabaB2	BebekB2	Oyuncaklar	TopA3	BaktopA3	ButopA3	ŞutopA3	OtopA3	AlitopuatA3	OyatopuatA3	AlitopututA3	OyatopututA3	ArabaA3	Bu arabaA3	BebekA3	TopA4	BaktopA4	ButopA4	OtopA4	ŞutopA4	AlitopuatA4	OyatopuatA4	AlitopututA4	OyatopututA4	ArabaA4	BuarabaA4	Ali arabayı tut	Ali arabayı sür	BebekA4	OyaBubebekA4	A	O	Ali	Oya	KendiAdı
B.Ö.	0	4	4	4																																									
B.Ö.	1	4	4	4				4	4	4					4	4	4																														
B.Ö.	2	4	4	4											4									4		4	4		8	5																
B.Ö.	3																										10		5			7	6										4		8
B.Ö.	4																										4		5	10	5						10				7					
Y.K.	0	0	0	0																																									
Y.K.	1	0	0	10				0	0	0	2	0	4		4									4		4	4								4				4						
Y.K.	2														4					6	6			4		4			8	8		6	6											
Y.K.	3	0	0	0	10	0	0	0	0	0	4	0	4		8														9	10		7	6											
Y.K.	4	0	0	0	10	10	10	10	10	0																						9	9											
İ.D.	0	0	0	0																																								
İ.D.	1	8	0	0	3	4	3	0	0	0	0	0	0		3									4		3																			3
İ.D.	2	4	0	0	3			4	3	0																																		
İ.D.	3	0	0	0	4	3		3	4	0					3									4		4		1	1				1											
İ.D.	4				3	3					4	3															4									3									
S.Y.	0	0	0	0																																								
S.Y.	1	0	0	0	3	3	3	3	3	3					3									3		3																			
S.Y.	2	0	0	0	3	0	0	3	3	3					4,5		5		1					4		4	0																8	8			
S.Y.	3	0	0	0	4,5	4	3	3	3	3					4,5	4,5	4,5							8	5																				
S.Y.	4	4						4	4,5	4				4	4	5,5	5		3	6	6		6	4,5		4,5																8	10	10	3	

Student Number	Session	TopA1a	ArabaA1a	BebekA1a	TopB1	ArabaB1	BebekB1	TopA2	ArabaA2	BebekA2	TopB2	ArabaB2	BebekB2	Oyuncaklar	TopA3	BaktopA3	ButopA3	ŞutopA3	OtopA3	AlitopuatA3	OyatopuatA3	AlitopututA3	OyatopututA3	ArabaA3	Bu arabaA3	BebekA3	TopA4	BaktopA4	ButopA4	OtopA4	ŞutopA4	AlitopuatA4	OyatopuatA4	AlitopututA4	OyatopututA4	ArabaA4	BuarabaA4	Ali arabayı tut	Ali arabayı sür	BebekA4	OyaBubebekA4	A	O	Ali	Oya	KendiAdı
E.A.	0	4	4	4																																										
E.A.	1	4	7	7				4	7	7					4		5		5								4		5																		
E.A.															4		5		5	7	6						4					7	7				8	6	6						
E.A.	3																										10	10																	
E.A.																																7	9													