

m-Learning for Hearing Impaired Learners: Dimensions of Evaluation

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Abstract—Integrating information and communication technologies (ICT) in education is a very important factor to learning, regarding student centered learning environments. Special education thus, is a field where mobile technologies can be used very efficiently for less financial burden due to its small scale in student number in normal schools. These technologies are also known assistive technologies for learners in special education context. "Mobile Technologies for Students with Hearing Disability", IBEM is a project which will end in June 2009 and supported by the Scientific and Technological Research Council of Turkey (TUBITAK). Primary goal of the project is to help hearing impaired students to use mobile information and communication technologies effectively and independently, and provide them with learning and communication opportunities enriched through mobile technologies. The project consisted of different levels of planning. This study reveals the steps taken for evaluation phase for m- learning, giving the four dimensions' framework of an evaluation model followed.

Keywords—Hearing Impairment, m-Learning, Mobile Technologies, PDAs

I. INTRODUCTION

Mobile communication has influenced every aspect of our lives. Regardless of location and occasion, mobile technologies make it possible to communicate. M-learning, realized with mobile technologies, is the type of learning characterized by the usage of wireless technology, through the personal control of the learning time and place, under an autonomy level and limitations determined by the device[1]. Mobile technologies offer significant opportunities both for learners and educators in the process of knowledge society. Mobile technologies have the structure of independency of

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time and place, so mobile technologies have found themselves an important use in e-learning supported by mobile technologies (m-learning). Information can be accessible, free from time and place, via mobile technologies which have an opportunity such as wireless communication. Based on their portability and wireless communication features, handheld computers, help special education students' in their education for example, mobile technologies allow for deaf and hard of hearing students reach verbal and written communication and learning experience.

PDAs have two basic purposes in mobile learning [30]:

- to provide sustained personal access to ICT, through which teachers might develop familiarity with relevant concepts and practices,
- to provide access to the projects and professional development materials

M-learning realized through use of mobile information and communication technologies have some advantages [25], mobile technologies;

- provide a motivational stimulus
- offer ease of storage and portability
- contribute to improved written work
- make it easier to produce written work
- increase knowledge of computers
- offer a range of useful functions
- readily available at all times

M-learning has some application limitations in terms of the technical infrastructure needed. Besides, learners' knowledge on and attitudes toward technology use influence m-learning applications as well. These limitations could be listed as follows [31]:

- Small PDA screens limit the amount and type of information to be displayed,
- Storage capacities for mobiles and PDAs are limited,
- Batteries need to be charged regularly, and data lost might occur if this is not done correctly,
- They are less robust than desktops,
- It's still difficult to use moving graphics, although 3G and 4G will eventually allow this,

- Devices can become out of date very quickly since it is a fast-moving market
- bandwidth may degrade with a larger number of users while using wireless networks

Use of mobile technologies in education for M-learning is invaluable but not economical for emerging countries, however mobile technologies can be used to improve students' learning and communication processes where the number of students is scarce. Special education thus, is a field where mobile technologies can be used very efficiently for less financial burden due its small scale in student number in normal schools. Besides, it gives the advantage to students of special education to attend normal education classes. Benefits of implementing these technologies for special students are as follows [2];

- maximize independence in academic and employment tasks,
- increase participation in classroom discussions,
- help students gain access to peers, mentors and role models,
- help them self-advocate,
- provide them with access to the full range of educational options,
- help them participate in different experiences not otherwise possible,
- provide them with the opportunity to succeed in work-based learning experiences, secure high levels of independent living,
- prepare them for transitions to college and careers,
- give them the opportunity to work side-by-side with peers,
- help them enter high-tech career fields,
- encourage them to participate in community and recreational activities.

Regarding all the benefits of using mobile technologies, a project was undertaken at Anadolu University in Turkey the project is entitled "Mobile Technologies for Students with Hearing Disability" (İşitme Engelli Bireylerin Eğitiminde Mobil Teknolojiler –IBEM, project number: 107K022) with a particular emphasis on planning and development[3]. IBEM is a two-year project which will end in June 2009 and supported by the Scientific and Technological Research Council of Turkey (TUBITAK).

The research was carried out in a School for the Handicapped. This school was established in 1993. There are 150 hearing impaired students enrolled at this school. Sign Language is not used within the university however students are free to communicate in sign language. This two-year degree program is modified to accommodate hearing impaired students who are allowed to complete the program in three or four years. There are currently four career choices: Computers, Ceramic Arts, Graphic Arts, and CAD.

School for the Handicapped started during 1993 academic year. The aim of the school is to offer special education for the handicapped in vocational programs and thus enabling them to become productive members of the community. The

Department of Applied Fine Arts offers undergraduate programs in both ceramic arts and graphic arts. Department of Administrative Vocations and the Department of Architecture offer two-year degree programs in computer operator training and architectural drawing. These departments are equipped with the necessary technological aids to accommodate the educational needs of the hearing impaired. Students are provided with the latest audio visual teaching aids, PC and MAC laboratories and access to the internet [17].

The primary goal of the project is to help hearing impaired students to use mobile information and communication technologies effectively and independently, and provide them with learning and communication opportunities enriched through mobile technologies. In addition, it is also aimed to investigate the ways to overcome learning and communication problems faced by special students, which are mostly difficult to be eliminated through known methods and procedures. The project is being implemented through a multidisciplinary perspective in which instructional technologists, special education experts and research methodologists participate. A multi dimension instructional approach was considered for the project so different stages of the project were concerned as different study units [4]. This study reveals the procedure considered for evaluation of the M-learning realized in the project.

However, it is a good idea to rethink the instructional context of the project first to understand the evaluation. As given in Odabasi, Cuhadar and Kuzu, the instructional context should be clearly identified and described in detail in order to develop a sound instructional design. This context involves several dimensions such as learner profiles, instructional objectives, instructional content and context, and evaluation. In order for instructional practices to be successful, it is crucial to have sufficient and detailed information about the individuals who will make use of that instruction such as gender, age, prior knowledge, and learning styles [26]. Twelve students with different levels and reasons of hearing impairment participated in the current research, eight females and four males. As of 2007 Fall semester, participants pursue their education at the Graphic Arts Program at the Department of Applied Fine Arts at Anadolu University School for the Handicapped. The research has been designed to investigate the ways to implement mobile technologies in the education of hearing impaired students. These students' language and speaking insufficiencies prevent them from perceiving the societal practices and making use of educational opportunities properly [12]. Thus, it is important to implement technology supported practices to enrich special students' experiences on a social and instructional basis.

IBEM participants have been selected from hearing impaired undergraduate students in order to address the need to enrich their social and instructional experiences. The purpose is to provide these students with effective communication and learning experiences through enriching their daily communication endeavors and learning contexts via mobile technologies. Participants of the current study were at the beginning of their bachelor degree, that is, their social relationships are supposed to be at an elementary level, which is another reason to select them. The social and instructional inexperience in the undergraduate level is considered as an

opportunity as the purpose of the current research is to ameliorate both instructional and social experiences of the participants.

The framework is primarily based on investigating the opportunities and guidelines to improve hearing impaired students' learning and communication experiences through the use of mobile technologies. A mobile learning environment has been developed where students are able to follow the content of the course and continue their social interactions through their personal digital assistants without being affected by time and place boundaries. Rather than creating a manipulated experimental context, the natural learning and interaction experiences of special students were supported through authentic means. Thus, one of the core courses of their current program entitled 'Fundamentals of Information Technology – I' was selected for the implementation of the research. The contents of the course were modified by the course instructor and the instructional design team in accordance with the unique needs of the students.

II. EVALUATION OF IBEM

Children with prenatal or pre-language hearing loss face great difficulties especially in acquiring their native languages. This is because while hearing children acquire their native languages with the aid of hearing channel in natural environments without much difficulty, the handicapped children can not properly perceive what is uttered and fully benefit from the audio feedback, so they also have difficulty in controlling their voices [27]. In other words, while hearing children can acquire especially the speaking dimension of their native languages via the help of their audio lives without having difficulty, hearing impaired children cannot partly or fully hear the sounds around them, especially the speaking sounds due to the hindrances in hearing channel, so they face problems in understanding the speech and acquiring the production dimensions.

Achieving effective communication skills through speaking or using signs is not sufficient for hearing impaired children. In order for the hearing impaired children to completely develop their academic and intellectual skills, it is also necessary to develop reading and writing dimensions of oral communication effectively. Thus, there is need for new approaches and methods which will be effective on hearing impaired children' cognitive, social, emotional and academic success levels which develop differently from their peers. Thus, m-learning environments which allows for teaching and learning opportunities free from time and place is a very effective choice for the education of hearing impaired children.

Sound becomes, through experience and training, familiar symbols of a concept or situation. They give information which orients us in our environment. However, in some cases the intactness of auditory system is impaired with some reasons and we talk about hearing loss [19]. Technology should be used for the hearing impaired individuals to assist

overcoming communication barriers caused by their hearing losses as in all impairment groups. Assistive technology concept is mostly given as "any of a wide variety of technology applications designed to help students with disabilities learn, communicate, and otherwise function more independently by bypassing their disabilities" [5].

The term assistive technology may encompass a wide variety of materials from pictures to IT of high level. Assistive technologies can be roughly defined as objects, tools, visual stimuli and products of high technology which are used for individuals with hearing impairments to increase their communication skills [23]. Practices which employ low technology in special education are strategies which can not be applied by using battery or electrical power used widely for visual assistive systems. Moreover, such practices are cheap and easy to prepare and use. Strategies applied by using battery or simple electronic power are among the practices employing average level technology. Practices with high technology are the ones which employ more complicated technologies than average level technology practices [24].

Thus mobile technologies with their flexible characteristics of being wireless and accessible everywhere, are invaluable technologies for students with impairment. It might not be a good idea to call mobile technologies only as assistive technologies since they can be used as efficiently as instructional technologies. When instructional endeavors realized through mobile technologies are examined, two types of applications seem to be the most commonplace [6]:

1. Transmission of content to students through portable computers and wireless networks which allows realization of e-learning applications without depending on time and place,
2. Transmission of electronic course materials, sustaining collaboration and communication among students in traditional instructional settings.

Hearing impaired children follow the same processes followed by their hearing peers during learning, but, because of their impairment, their language acquisition, reading comprehension, and written production are later realized in comparison to their intact peers. However, the majority of efforts by assistive technology specialists to make reading materials accessible have involved scanning textbooks into the computer and teaching students to use text-to-speech software so they can listen to information that they could not read independently. Not every technology can be a solution to every problem. It is very important to schedule your priorities and follow them [18]. In our case, IBEM Project, we saw our problem was due to limited comprehension so we acted accordingly.

IBEM is realized through the second approach however the evaluation stage was not as rigid as this choice of application stage. A group of researchers thought that applying the steps of a Functional Evaluation of Assistive Technology, FEAT would be beneficial so the matrix was formulated as [7]:

TASK <i>The specific task/ functions to be performed and the requisite skills associated with the task.</i>	INDIVIDUAL <i>The individual's specific strengths, weaknesses, special abilities, prior experience/knowledge, and interest</i>
DEVICE <i>The specific device</i>	CONTEXT <i>The specific contexts of Interaction</i>

Fig.1 Components of multidimensional assessment model for assistive technologies [8]

In order for students with hearing impairment to leverage their academic and intellectual skills, these students must first maintain their reading and writing skills. Therefore we need new approaches and methods to enhance these students' cognitive, social or psychological developments. Mobile technologies which provide teaching and learning opportunities independent from time and place, and support interaction between individuals offer devices suitable for the education of hearing impaired students.

The evaluation of IBEM which helps hearing impaired individuals use the portable information and communication technologies effectively and consciously, and aims at providing them with learning environments and communication opportunities enriched with these technologies is covered in four dimensions.

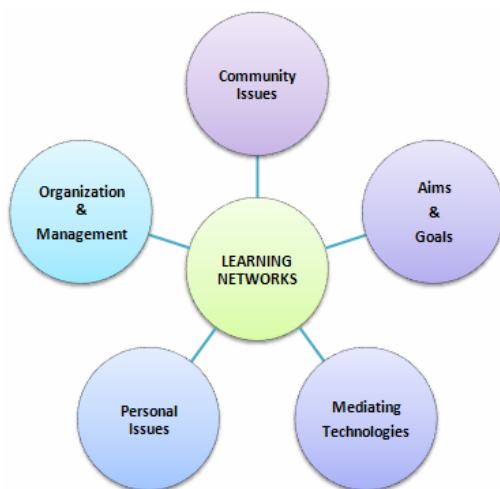


Fig 3: Crucial areas in networking process (Adapted by: Bottino, 2007) [14]

A. Task

The first dimension of the model created to evaluate the special education practices employing assistive technology is Task category which handicapped individuals do in their natural environments, and each of which requires certain daily skills to succeed in [8]. In this dimension, it is notable that the environments where handicapped students are familiar with, and carry out their daily lives are taken into consideration in the evaluation process. Conducting the evaluation process in these environments help gain information about behaviors, skills, and routine activities expected to occur in these environments, and practicality of the assistive technologies used.

The hearing impaired students' communication skills improve and they gain professional and daily life skills during their university education [9]. IBEM has formed an interactional learning infrastructure made up of current technologies, and endowed the hearing impaired individuals with distinctive teaching experiences transferable to their daily lives. Another contribution of m-learning to the traditional teaching environments in the context of using mobile information and communication technologies for learning is the distribution of the course materials most of which are now electronically. Moreover, students can carry the electronic course content with them thanks to these devices. These devices furnished with wireless network provide opportunities for team work inside and outside the classroom, and enable students to ask questions to their teachers and classmates, and get answers in any time and place.

B. Individual

Individual evaluation in which the individual characteristics of handicapped individuals are taken into consideration is the second dimension. The concepts such as knowledge, experiences, strengths, weaknesses, special skills of handicapped individuals are covered in this dimension [8]. Parental hearing status can have a major influence on the quality and quantity of linguistic experiences available to young children who are deaf [10]. If this impair brings in hindrance for the child to perceive, distinguish and understand the linguistic differences, especially in the first two years of the child's life, the child will face a great risk in acquiring his mother tongue. As a result, it is quite probable that he will face problems with regard to developing academic skills in the following periods of his life [11]. Each dimension of the model constitutes the whole in evaluation. However, technology choice, task definition, and some contextual properties can be directly or indirectly limited due to the reasons caused by the handicap the individual has. Therefore, it can be suggested that the individual dimension can present a general framework for the evaluations conducted in other dimensions.

Each hearing impaired student who is the participant of the project has different levels of hearing loss occurred before or after birth. They had studied at special education institutions before they entered university. In observations and pilot

studies, it has been observed that hearing impaired students frequently communicate with each other with their cell phones, especially by using the SMS service of their phones. It has been understood that each participant has the preliminary technologic information and skills necessary to participate in the course activities and social activities carried out in the scope of the project whose infrastructure is based on mobile technologies.

C. Device

Another dimension taken into consideration in evaluating the assistive technologies is Device. Mobile computing, cell phones, and other wireless technologies can benefit from systematic frameworks to identify user-centered requirements to enhance accessibility and usability of products [21]. The devices used in daily life and education of hearing impaired individuals show variations according to their functions and technological infrastructures. Therefore, it is necessary to take into account the specific properties of the assistive technology when performing device evaluation [8].

In the project, usage of mobile information and communication devices, and the activities which will increase the social interaction of hearing impaired individuals in their education and daily lives are given place. The devices in question have properties to enrich the teaching and social interaction thanks to their communication skills independent from time and place, multimedia applications, and information storage and display opportunities. However, several limitations such as these devices' small screens and battery life occurred in the application process.

Pocket computers called PDA (Personal digital Assistant) were used in the project to support the face to face courses and enrich the interaction opportunities. PDAs are devices used widely in m-learning practices. These devices work with operation systems such as PalmOs, Symbian, and Windows CE which are developed specifically for them. They have screens which can be controlled by touching. They can make wireless communication with other devices (PC, printer, etc.) possible by using mobile communication standards like Bluetooth [6].

It is possible to distribute and carry the course content in m-learning environments which employ PDAs. These devices are smaller versions of desktop computers, and have the technical equipments which can enable students to continuously carry and display the course content. Students can reach the course materials they have downloaded to their PDAs and any information they look for with internet access independent from time and place. Some learning activities achieved by students using PDA in the scope of course can be listed as follows:

- Carrying out the course activities assisted with PDA
- Sending homework through PDA
- Chatting with friends
- Continuous communication with classmates
- Researching homework topics on the internet
- Using it as portable disc

Communication between people is based on the desire to share opinions, information and emotions with others. That hearing impaired children can communicate with each other in their unique signs without receiving any education or help show how strong the desire to communicate is for people. However, speaking or using signs is not enough for gaining effective communication skills. Another important feature of PDAs is that they can provide hearing impaired students with social interaction among each other without time and place limitation thanks to their wireless communication property.

Students are in a continuous communication with the help of these devices. Moreover, hearing impaired students used synchronous chat, forum and e-mail services thanks to a virtual platform designed for them in addition to sending message and talking opportunities a cell phone offers. PDAs are advanced devices which provide all these opportunities to hearing impaired students in education and social interaction dimensions. Apart from the course activities, there are some activities hearing impaired students do with their PDAs such as:

- Sharing information
- Chatting
- Sending pictures
- Playing games



Fig.3 PDSs as an assistive technology for İBEM

D. Context

Context is the last dimension completing the evaluation model. The features of the context where the daily life is spent is a factor which also defines the limitations of the education in accomplishing teaching for hearing impaired individuals. Speech and sounds are important sources of information in our everyday lives for communication with our environment, be it interacting with fellow humans or directing our attention to technical devices with sound signals. For hearing impaired persons this acoustic information must be supplemented or even replaced by cues using other senses [20].

Unique contexts and interactions such as house, school, and work that an impaired individual spends time in his daily life constitute this dimension. How the assistive technology used can be adapted to the unique context that the impaired individual is involved in is covered in the evaluation [8]. Context is also considered as a dimension which includes the evaluation process of the settings the handicapped individuals interact with in their daily lives, and the interaction and communication they have with the other individuals such as family members, and friends in these settings. Various traditional communication strategies such as mimes, signs, symbols and sounds are used between hearing individuals and hearing impaired individuals. In many contexts, the conversation with the hearing person is taken no further, because these communication strategies are too basic [22].

The theory of context-oriented communication theory [15] led to a sophisticated concept of annotations where these annotations serve as communicative contributions and (segmented) material and previous annotations are used as context [16]. Hearing impaired students need to have education in teaching contexts which are arranged according to specific standards due to their hearing loss. Hearing impaired individuals need to have education in places where the level of noise is at minimum and sound insulation is guaranteed [12]. Basic Information Technologies – I course that the project took place in is applied face to face in classroom setting, and through mobile devices in electronic setting. The face to face part of the course which took place in classroom setting was carried out at the computer laboratory of the School for the Handicapped, Anadolu University. There are a total number of 13 computers which have Internet/intranet connection at the computer laboratory. A video projector is connected from these computers to the main computer that the lecturer of the course uses. There is also an electronic board and a white board for the lecturer to perform the course activities at the laboratory.

A unique context has been created in the scope of IBEM taking into account the physical setting choice, face to face and virtual course settings, and the properties of hearing impaired students caused by their handicaps. The participants of the project were in a continuous interaction with their lecturers, peers, and assisting personnel in the scope of the project.

Each dimension of the evaluation of the IBEM is based on the model described in this article. The dimensions constituting the model were examined in terms m-learning approaches and in accordance with the needs of the target

group. Dimensions of the modal are interrelated. During the project implementation process, each dimension were structured without disconnecting the dimension from the whole model. Evaluations regarding the whole process were conducted according to decisions taken in accordance with relevant instructional design principles.

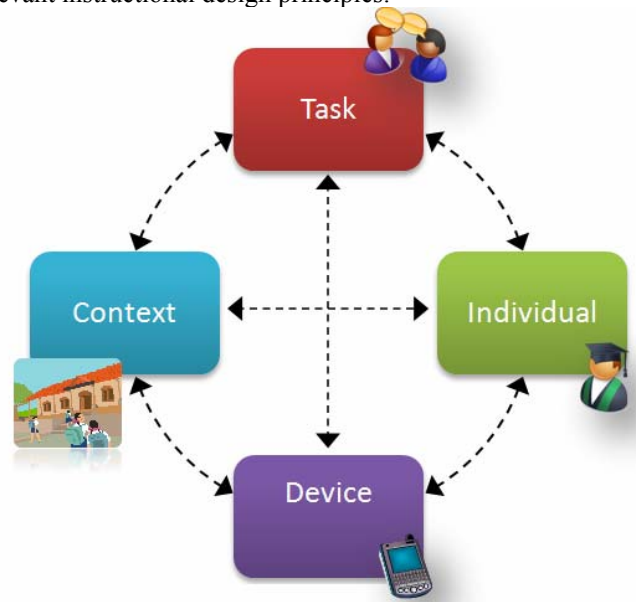


Fig.4 Interaction of evaluation components of IBEM

III. CONCLUSIONS

Computers can improve human senses, or substitute one for another. They can do even more, and operate different devices such as home appliances. Even for persons with the most severe challenges, the computer is a helpful tool with which to communicate and control the environment [29]. Mobile technologies offer significant opportunities both for learners and educators in the process of knowledge society. Mobile technologies have the structure of independency of time and place, so mobile technologies have found themselves an important use in e-learning supported by mobile technologies (m-learning) information can be accessible, free from time and place, via mobile technologies which have an opportunity such as wireless communication. By means of their technical features, mobile technologies can be used not only for educational purposes Accessing but also for increasing social interaction. Based on their portability and wireless communication features, handheld computers, admitting of verbal and written communication, allow for deaf and hard of hearing students reach communication and learning experience. Based on Mobile Technologies in Deaf and Hard of Hearing Persons Project (IBEM), offer use of mobile Technologies in educational settings for hearing impaired students and tries to pinpoint the difficulties faced in practice.

The issues required to support the changes proposed through the use of ICT are far ranging and involve changes in

curriculum, the need for ongoing faculty development, securing and maintaining adequate resources, and ongoing evaluation [13]. ICTs make it possible to compensate for even serious deficiencies of the sense organs and supporting-motor apparatus. In cases of deaf and hearing impaired, as well as blind and sight-impaired children, ICTs are used to enhance the functioning of a weakened organ, or to substitute for an inoperative one [28]. When the individuals who need special education are under question, technology is perceived only in the scope of assistive technology such as hearing devices, and orthopedic walking kits. However, individuals who need special education can also use technology for instructional facilities. The rich multimedia resources brought by the mobile technologies to the learning settings create a bigger education potential with time and place flexibility. Moreover, the mobile technologies enable the social interaction between learners to continue outside the campus thanks to their portable properties and communication capacities.

At this point, PDAs being appropriate for hearing impaired students gain importance. "Mobile Technologies for Students with Hearing Disability (IBEM)" project helped the education process of hearing impaired students be more flexible. In addition to providing a flexible education, the use of technology in educational settings will give hearing impaired students freedom, and increase the level of interaction between themselves and their motivation, thus the self-confidence of hearing impaired individuals will improve.

In our era which necessitates using information and communication technologies for instructional purposes, thanks to the structures enabling mobile and wireless communication, mobile technologies enable learners to communicate and access information independent from time and place. In order to realize education assisted with mobile technologies effectively and fruitfully, there is need for research which will help analyze such environments in instructional and social dimensions. IBEM aims at helping hearing impaired individuals who are a part of our society to use mobile information and communication technologies effectively and consciously, and providing them with education environments enriched with these technologies and communication opportunities. Furthermore, IBEM is planned and realized with an interdisciplinary approach for the education of computer and teaching technologies and the education of hearing impaired individuals. Studies on employing information and communication technologies in environments which provide education for the individuals with special education needs are increasing and gaining importance day by day. Advantages and limitations of such studies are uncovered thanks to IBEM. Moreover, IBEM helps find out how to overcome the problems that hearing impaired individuals encounter in their instructional environments and daily lives and that are difficult to solve with the traditional methods with the help of mobile devices.

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