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# Integrating Mobile Applications into Hearing Impaired Children's Literacy Instuction

Fatih Yaman [1], Onur Dönmez [2], Elif Avcı [3], Işıl Kabakçı Yurdakul [4]

## Abstract

Literacy is a fundamental skill to function in society. However, hearing impaired are severely disadvantaged in literacy development by lack of access to language's phonemic system. Recent developments in information and communication technologies stimulated technology integration endeavors in special education field. Hearing impaired children's literacy instruction stands a fruitful area of technology integration. Former studies generally reported development or examination of supportive tools like visual dictionaries, sign language support, vocabulary drills or storybooks. However, few studies developed an overall approach and reported whole technology integration procedures. This study reports findings from a research which investigated the affordances of mobile devices in hearing impaired children's literacy instruction. Two mobile applications were built from scratch and optimized through design based research. Furthermore, affordances and integration guidelines of these applications were investigated in a case study. The research was conducted in Anadolu University's Applied Research Center for Hearing Impaired Children (İÇEM). Participants of the study are hearing impaired children studying at İÇEM in 2013-2014 and 2014-2015 academic years. Data sources of the project were observations, video recordings, audio recordings of expert panels and semi-structured interviews. The data were analyzed inductively using NVivo 10 software. Results suggested significant increase in student motivation towards the technology enriched instructional environment. This paper summarizes design and optimization studies along with technology integration guidelines to hearing impaired children's literacy classes.

## Keywords

Hearing-impaired children
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Mobile storybook

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[1] Anadolu University, Faculty of Education, Department of Computer Education and Instructional Technologies, Turkey, fatihyaman@anadolu.edu.tr
[2] Ege University, Faculty of Education, Department of Computer Education and Instructional Technologies, Turkey, onur.donmez@ege.edu.tr
[3] Anadolu University, Faculty of Education, Department of Fine Arts Education, Turkey, elifa@anadolu.edu.tr
[4] Anadolu University, Faculty of Education, Department of Computer Education and Instructional Technologies, Turkey, isilk@anadolu.edu.tr

## Introduction

Literacy is a fundamental skill to function in society, in terms of fulfilling the basic interpersonal communication roles and participating in society (Kirsch, Jungeblut, Jenkins, & Kolstad, 2002). The linguistic approach assumes literacy emerges from oral language, which develops naturally. Children develop phonological awareness and acquire language's fundamental phonemic sound system through listening to nearby conversations (Magee, 2014). However, Hearing Impaired (HI) are severely disadvantaged by lack of access to language's sound system. Several studies reported HI children had poor performance on literacy tests and struggled to attain literacy levels of typical hearing counterparts (Sanders, 2013). Karal and Şılbır (2010) reported, hearing impaired children's reading were hindered by limited vocabulary and pronunciation skills. Nevertheless, special education programs represent considerable potential to compensate HI children's disadvantages. These programs can advance children's literacy skills by targeting foundational skills like oral language, phonemic awareness, vocabulary, syntax and sentence construction (Schirmer, 2000; Tüfekçioğlu, 2002).

Motivation is a major element of success for any instructional program (Richek, Caldwell, Jennings, & Lerner, 2002). Programs must engage learners with innovative learning materials and activities that conform learners' ages, interests, knowledge levels and language skills (Girgin, 2003). ICTs represent a resourceful option to stimulate HI children's motivation in learning activities. Justice (2006) enumerated several affordances of ICTs for HI children's reading activities: a) augmenting content and concepts, b) supporting interaction between text and reader, c) supplying individualized clues for reader, d) facilitating comprehension, e) facilitating instruction. Furthermore, several studies reported hearing impaired children had high aspirations for technological materials and technology-rich learning activities (Dickerson, Williams, & Browning, 2009; Ju, 2009; Karal & Çiftçi, 2008; Kuzu, Odabaşı, Uzuner, & Girgin, 2009). Kuzu, Odabaşı, and Girgin (2011) reported HI children had positive attitudes for mobile devices and enjoyed ubiquitous access to learning content and information resources. Drawing upon observations on HI children's heavy messaging/texting and information retrieval exercises on the Internet, Maiorana-Basas and Pagliaro (2014) asserted HI children's literacy instruction should take advantage of digital devices' potential.

Potential of ICTs advocated by a rich repertoire of studies with positive learning outcomes in literacy instruction. A meta-analysis of 29 studies suggested multimedia storybooks were more beneficial for hearing impaired children compared to printed storybooks (Takacs, Swart, & Bus, 2014). Masitry, Majid, Toh, and Herawan (2013) reported more than %80 decrease of mastery time for multimedia supported sign language courseware compared to traditional courseware. Donne and Briley (2015) showed that, compared to printed materials, HI children learned more vocabulary with multimedia storybooks regardless of their language skills. Wang and Paul (2011) achieved higher levels of vocabulary and reading comprehension through Cornerstones approach which elaborated digital materials like animated stories, games, story maps, character schemes and illustrations. Çiftçi (2009) attained increased sentence construction and post-fix selection performance through computer supported learning materials which targeted writing skills. These studies promote the the assumptions regarding technology integration's potential in hearing impaired's literacy instruction.

The recent proliferation of mobile devices brings these technologies into current research agenda. Mobile devices have several advantages over their predecessors including mobility, personal use, ubiquitous internet access and rich multimedia applications. These hardware capacities promote mobile devices for all educational settings (Girgin, Kıyıcı, & Tanyeri, 2008; Stinson, 2010). Besides, content wise, application stores offer a great variety of applications for any educational need (Watlington, 2011). Taking advantage of these capacities mobile devices offer a huge potential for classrooms. However, teachers and practitioners struggle to find mobile applications specific to their classroom's needs.

Mobile devices facilitate creation and implementation of multimedia-rich instructional content specific to small target populations (Ostashewski & Reid, 2010). For example, Ng'ethe, Blake, and Glaser (2015) developed a prototype for HI's computer literacy instruction. This prototype conveyed the content through South African Sign Language videos. The technical aim of the prototype was to create a self-paced mobile learning environment for HI individuals. Results suggested, the prototype enabled HI to learn at their own pace and reduced teacher dependence.

Reading classes are expected to benefit from visual cues, vocabulary practices, multimedia elements and interactive motivational elements on mobile devices. Combined with viable instructional strategies these applications can facilitate children's comprehension, deduction, meaning making and identification skills (Justice, 2006). However, reading applications for hearing impaired children were generally designed as e-books with sign language support (Hancock & Parton, 2011). Since most of the applications focused on sign language and profit, mobile technologies have yet to accomplish their potential in hearing impaired classes (Butler, 2011). This fact is reflected in Lidström and Hemmingsson's (2014) study which investigated the affordances and use cases of ICTs in disabled people's education. A review of literature from 2000 to 2012 revealed merely 32 articles for disabled people, of which only five were for hearing impaired. Liu, Wu, and Chen (2013) examined technology integration studies within special education literature in terms of research aims, methodologies, outcomes, target groups and technologies. In parallel to former study, review of literature from 2008 to 2012 suggested, only three studies targeting hearing impaired. These studies indicate the lack of research for hearing impaired. Furthermore, related literature mainly reports the results of technology integration endeavors (Karal & Şılbır, 2010; Krannich & Zare, 2009; Lee, Kim, Lee, & Lim, 2013; Wang & Paul, 2011). However, very few studies presented design, development and utilization procedures of instructional materials, which are very important for successful technology integration (Dönmez, Yaman, Şahin, & Kabakçı Yurdakul, 2016; Glova, Asuncion, Martin, Manzan, & Pagtaconan, 2015). In this context, the aim of the current study is to delineate development, optimization and evaluation studies of a mobile reading comprehension package for hearing impaired children's literacy insturction. This package consists two mobile applications called "storybook" and "story map".

## Method

### *Research Model*

This study was elaborated in two major phases (Figure 1). First phase was a design based research where Mobile Reading Comprehension Package (MRCP) was created and optimized. The second phase was a case study which MRCP was investigated within a new setting.

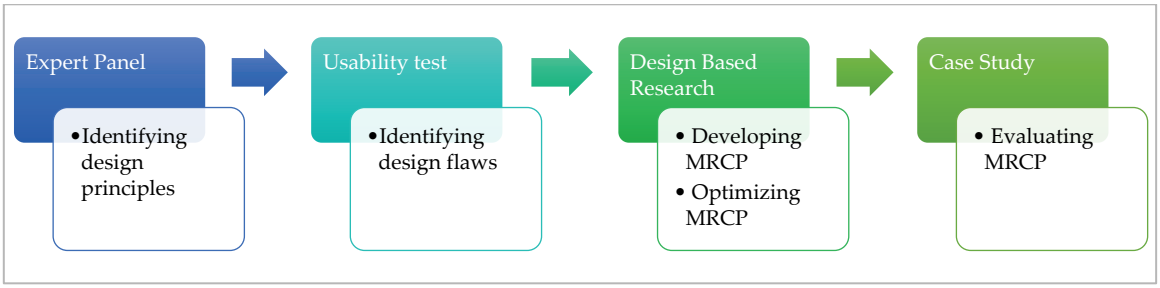


**Figure 1.** Research Process

Development phase began with identifying artistic illustration guidelines. Special education experts prepared a pilot story for development studies. Pilot story was analyzed and partitioned into pages through an expert panel. Following this expert panel, the fine arts expert prepared drafts as initial illustrations for the pages. Two experts from fine arts and special education fields reviewed initial illustrations through semi structured interviews. Analysis of interview scripts resulted in authentic illustration guidelines for the project.

Along with artistic guidelines, technology experts created initial designs for applications. These initial designs were optimized through formative usability tests within the frame of a design based research. Formative usability tests are iterative optimization studies where the main objective is to improve a product (Tullis & Albert, 2013). Researchers diagnose design flaws, evaluate possible solutions and implement changes on each optimization cycle. Optimized product goes into the next optimization cycle until a satisfactory design is achieved. There are several metrics for evaluating a pruduct's usability. For example, Nielsen (1994) identified five dimensions of usability as: learnability, efficiency, memorability, small margin of error and user satisfaction. Tullis and Albert (2013) further elaborated usability metrics under four themes: performance metrics (eg. time on task, task success), issue based metrics (eg. severity ratings, frequency), self-reported metrics (eg. user ratings, satisfaction surveys), behavioral and psychological metrics (eg. eye tracking, observation forms). Given the delicate nature of participants this study employed a few of these metrics: time on task, task success, number of errors, learnability and efficiency.

Contemporary approaches regard learning as a composite structure where cognition, knowing and context are intertwined (Barab & Squire, 2004). Since these components cannot be isolated, researchers need to examine learning holistically in its very nature. This view entails new research and development practices where theory, design and application converge (Kuzu, Çankaya, & Mısırlı, 2011). In response to this need, design based research is a recent approach where contemporary technologies, innovative learning tools and complex instructional approaches are examined in real learning settings (Sandoval & Bell, 2004). Design based research examines learning in its own context by systematically observing and modifying relevant variables. Researchers, instructional designers, teachers,

practitioners and learners collectively and iteratively run design cycles where analysis, design, development, implementation and evaluation activities are conducted. This approach results in context specific design principles, theories and instructional activities (Wang & Hannafin, 2005). Thus, design based research formatively evaluates highly theoretical instructional designs by taking advantage of theory-design and implementation interaction (Cobb, Confrey, Lehrer, & Schauble, 2003; Collins, Joseph, & Bielaczyc, 2004; Kuzu et al., 2011). This study used design based research to create and optimize MRCP in real classroom settings (Figure 2).

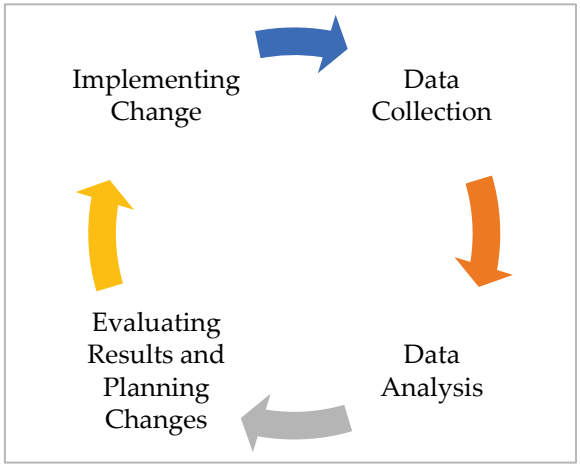


**Figure 2.** Design Based Research Cycle

Following design and optimization studies, the MRCP was evaluated through a case study within a new classroom setting. Case study is a qualitative research technique where researcher focus on a case which may be anything ranging from an individual, institution, community or society. Researcher tries to reflect participants' views by examining case in its natural form (Gall, Gall, & Borg, 1999). Bogdan and Biklen (1998) considers case study as an examination of a context, an individual, a document or an event. Creswell (2012) defines case study as in-depth exploration of an activity, event, process or an individual through systematic data collection.

***Research Context***

This study is a part of the project that was supported by The Scientific and Technological Research Council of Turkey (Grant Number: 112K595). The project is carried out in the Anadolu University's Applied Research Centre for the Education of Hearing-Impaired Children (ICEM), which is the Turkey's unique institution with 35 years of teaching and research experience for hearing impaired children. ICEM adopts auditory-oral approach to teaching within a wide range of qualified instructional programs and activities. ICEM constitutes a successful model for national and international institutions on educating hearing impaired children. Besides, this study brought together experts from three distinct disciplines (Table 1).

**Table 1.** Researchers' Disciplines, Expertise Fields and Roles

| Discipline | Expertise | Roles |
|---|---|---|
| CEIT | Qualitative research, technology integration | Data collection, analysis, administration |
| CEIT | Educational technology | Advisor |
| SE | Teaching hearing impaired | Writing stories and planning lessons |
| SE | Teaching hearing impaired | Advisor |
| CEIT | Qualitative research, software development | Data collection, analysis, application development |
| CEIT | Qualitative research, software development | Data collection, analysis, application development |
| SE | Teaching hearing impaired | Advisor |
| CEIT | Qualitative research | Data collection, transcribing, analysis |
| FAE | Digital illustration | Character design, illustrating stories, |
| SE | Teaching hearing impaired | Data collection, classroom teaching |
| CEIT | Qualitative research, technology integration | Data collection, analysis, administration |

*CEIT: Computer Education & Instructional Technology, SE: Special Education, FAE: Fine Arts Education*

Researchers observed ICEM's Turkish Language classes and identified following major steps:

- Reading the text.
- Explaining unknown vocabulary and using them in sentences.
- Answering questions on text (open ended questions, knowledge/experience questions, deduction questions).
- Creating story maps by analyzing characters, places, tenses and events in the story.

***Participants***

The aim of the first stage was identifying major design guidelines for mobile applications. Participants of the first stage were field experts from fine arts and special education disciplines. Following stage aimed at identifying major design flaws in MRCP through a usability test. Participant of the second stage was a hearing impaired child studying at the ICEM (Table 2).

**Table 2.** Participant of Usability Tests

| Name | Age | Level of Hearing dB(HL) | Hearing Aid | | Age of Cochlear Implant Surgery | Age of Attending ICEM |
|---|---|---|---|---|---|---|
| | | | Right | Left | | |
| Aslı | 9 July 2000 | 73 | CI | CI | Age 3 | 6 year 2 month |

Optimization studies followed the usability tests. Participants of optimization studies were summarized in tables for individual mobile applications.

**Table 3.** Participants of 'Storybook' Mobile Application

| Name | Age | Level of Hearing dB(HL) | Hearing Aid | | Age of Hearing Aid (Month) | Age of Cochlear Implant (Month) | Age Attended ICEM (Month) |
|---|---|---|---|---|---|---|---|
| | | | Left | Right | | | |
| Burak | 115 | 95 | BtE | BtE | 22 | -- | 41 |
| Ceren | 122 | 120 | CI | BtE | 18 | 34 | 84 |

*BtE: Behind the Ear Device, CI: Cochlear Implant*

**Table 4.** Participants of 'Story Map' Mobile Application

| Name | Age | Level of Hearing dB(HL) | Hearing Aid | | Age of Hearing Aid (Month) | Age of Cochlear Implant (Month) | Age Attended ICEM (Month) |
|---|---|---|---|---|---|---|---|
| | | | Left | Right | | | |
| Burak | 115 | 95 | BtE | BtE | 22 | -- | 41 |
| Pelin | 126 | 85 | BtE | CI | 51 | 64 | 89 |
| Cem | 119 | 101 | CI | BtE | 14 | 43 | 74 |

**Table 5.** Participants of The Case Study

| Name | Age | Level of Hearing dB(HL) | Hearing Aid | | Age of Hearing Aid (Month) | Age of Cochlear Implant (Month) | Age Attended ICEM (Month) |
|---|---|---|---|---|---|---|---|
| | | | Left | Right | | | |
| Ege | 134 | 119 | CI | BtE | 18 | 24 | 94 |
| Emircan | 121 | 105 | CI | BtE | 33 | 74 | 72 |
| Yeliz | 125 | 109 | CI | BtE | 14 | 43 | 84 |
| Alper | 134 | 62 | BtE | BtE | 24 | - | 97 |
| Mehmet | 134 | 101 | CI | BtE | 10 | 46 | 72 |
| Arif | 133 | 117 | CI | BtE | 26 | 43 | 84 |
| Eren | 127 | 73 | BtE | BtE | 16 | - | 72 |

***Data Collection***

Researchers used several data collection techniques on each stage of the study. On the first stage an observation form was adapted from Çağıltay (2011) with aforementioned metrics. Two researchers observed the usability tests and filled in the forms independently. Besides, tests were videotaped and analyzed in expert panels which ended up with optimization plans.

The second stage was the design based research. Storybook and Story Map applications were optimized through five sessions (Table 6). These sessions took place in a Turkish Language class in ICEM on the Fall semester of 2014-2015 academic year. Two technology experts observed and videotaped the classes for expert panels. These records were analyzed along with experts' field notes. Each expert panel ended up with optimization plans for applications.

**Table 6.** Design Based Research Sessions Summary

| Student | Application | Date | Length |
|---|---|---|---|
| Ceren | Storybook | 14.11.2014 | 01:09:00 |
| Burak | Storybook | 05.12.2014 | 00:46:59 |
| Ceren | Story Map | 19.11.2014 | 00:38:45 |
| Cem | Story Map | 17.12.2014 | 00:26:49 |
| Pelin | Story Map | 24.12.2014 | 00:31:23 |

The case study stage was conducted in the Spring semester of 2014-2015 academic year. Two researchers from CEIT departments observed and took field notes on each sessions. Besides all sessions were videotaped with two cameras. While a camera focused on the teacher and blackboard, the other one focused on students. Finally, the last data source was researcher journals.

**Table 7.** Case Study Sessions Summary

| Application | Story | Date | Length |
|---|---|---|---|
| Storybook | Little Friends | 27.02.2015 | 01:29:35 |
| Story Map | | 24.04.2015 | 00:45:45 |
| Storybook | At the Amusement Park | 20.03.2015 | 01:26:47 |
| Story Map | | 20.03.2015 | 00:37:38 |
| Storybook | Playing on Trains | 03.04.2015 | 01:18:23 |
| Story Map | | 03.04.2015 | 00:37:36 |
| Storybook | Dangerous Joke | 17.04.2015 | 01:19:21 |
| Story Map | | 17.04.2015 | 00:38:42 |
| Storybook | Surprise Breakfast | 08.05.2015 | 01:18:05 |
| Story Map | | 08.05.2015 | 00:36:38 |
| Storybook | A Night Under the Tent | 22.05.2015 | 01:16:59 |
| Story Map | | 22.05.2015 | 00:39:54 |

***Data Analysis***

Research data were analyzed inductively. Creswell (2012) treats qualitative analysis as inductive reasoning. Inductive analysis reveals formerly hidden themes, dimensions, associations and notions through rigorous inspections on the data (Yıldırım & Şimşek, 2006). Patton (2002) asserts inductive analysis is a data oriented technique which reveals patterns in the data. Researchers began with reading through the data and found general structures for each research question. Researchers used Nvivo 10 software for analyses. Field experts from different disciplines came together in 39 expert panels for the validity and reliability studies of the research project. In these panels, research data were investigated and analyzed to make decisions on design and integration guidelines.

## Findings

Research findings were reported under the associated mobile application.

***Mobile Storybook***

Development of the mobile storybook application began with an original story (Little Puppy) dedicated to usability and design based research studies. The story was partitioned into pages via and expert panel. These pages were illustrated by fine arts expert and all content were packed into a mobile application by CEIT experts (Figure 3).


**Figure 3.** Initial Design of Mobile Storybook

Researchers identified four graphical design focuses: paging, page layout, character design, and screen aesthetics. These focuses iteratively examined on project meetings prior to expert consultation. Brief explanations for these focuses are provided below:

- **Paging:** Stories are partitioned into four pages. Major events on each partition are illustrated on the full-screen background. However, not all events were communicated in the illustrations to direct students' attention to the text.
- **Page layout:** İllustrations reflect the main theme on the page text. Font style, font height and line spacing are selected to conform students' prior experiences and developmental needs. Location of the page text varied to fill in the wide spaces on illustration.
- **Character design:** Characters on illustrations are designed to conform students' developmental, cognitive and socio-cultural backgrounds.
- **Aesthetic quality of illustrations:** Illustrations conform students' developmental, cognitive, cultural and emotional needs. Illustrations are colorful and realistic in style.

A pilot design was created and consulted to a fine arts education expert through a semi structured interview on 04.03.2014. Project members evaluated findings from this interview and concluded on following design improvements: the number of pages were increased; illustration styles were simplified; character designs were deformed and stylized; aesthetic quality of screens were empowered by a more linear drawing style; appealing of the screens supported through asymmetric balance and emphasis principles. Figure 4 illustrates final designs for Little Puppy story.


**Figure 4.** Screens from Little Puppy Story

Fine arts education expert emphasized the need for more pages.

- There are lots of actions and it is exhaustive to try every action in one illustration. You do not need to take the first screen in the house, Aslı and Ömer can come out … you can further partition these events. You need to reduce the text on each page. I believe you need more scenes (Voice Record 01: 19'56" – 20'23").
- There are a lot of actions and you need to reflect them in illustrations. Expressing events as much important as reflecting emotions. … It would be best to increase number of scenes (Voice Record 01: 21'28" – 21'51").
- I have mentioned the extent illustrations support the story. You must increase the number of scenes. Besides, it is aesthetically satisfying (Voice Record 01: 47'15" – 47'21").

Fine arts education expert asserted increasing scene count would support illustration-text relationship, visual fluency and integrity. In line with these suggestions, consequent stories partitioned into six pages which had several affordances. On the design side, having more pages facilitated easier streamlining of events and aesthetically better illustration options. Furthermore, students better recognized the characters and their story comprehension was promoted.

Expert panel (13.11.2014) decided to integrate comprehension questions into mobile storybook. These questions were placed after the story (Figure 5). This change was evaluated on a design cycle (14.11.2014). However, this design was found to have flaws which observed on video records and field notes.


**Figure 5.** An Example Question on Mobile Storybook

- After the student read out the fourth page of the story, the teacher asked "lets see what happens next". Students slides to the next page. Facing a question slide, student confuses and asks "what now?". Teacher notes the story is over and the student confirms. Teacher asks, "well then, have you understood the story?". Student replies "a little". Teacher examines her comprehension by asking her to tell the story. After retelling the story, teacher directs her to answer the questions (Video Record 01: 14'32" – 14':35").

Analyzing the situation, expert panel decided to insert a transition page between story pages and question pages. This page (Figure 6) asks reader to retell the story in his/her own words which promotes their comprehension and oral language development.

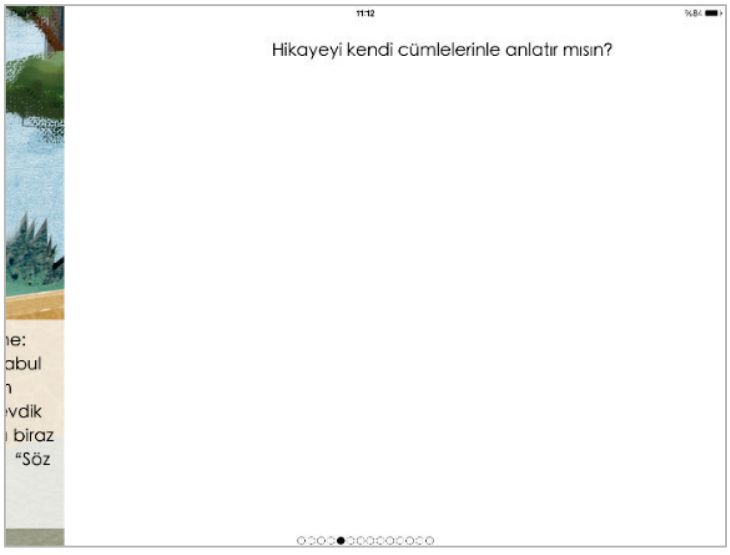


**Figure 6.** Transition Page on Mobile Storybook

The new design was evaluated on the next design cycle (19.11.2014). Yet another design flaw was missing cover page.

- Student read the Little Puppy story (Video Record 02-01: 00'27" – 05'13"). Then teacher moved on to the story map application. Teacher explained the aims and expected activities in story map application (Video Record 02-01: 05'38" – 05'47"). Following a brief introduction teacher asked Cemre the name of the story, which is the first activity in story map application. Cemre hesitated

for 5 seconds and asked "what was it?". Teacher moved back to the storybook application and explored the pages (recognizing the lack of cover page). Then teacher had Cemre guess the name of the story with questions (eg. "Do you remember the characters in the story?"). Cemre correctly guessed the name of the story and filled in the question (Video Record 02-01: 06'13" – 06'47").

The expert panel on 20.11.2014 decided to add a cover page to the stories (Figure 7). Development studies of the mobile storybook application was finalized with this optimization.


**Figure 7.** Cover Page of Storybook Application

***Story Map***

Initial design of the story map application is represented in Figure 8. The main goal of the story map application is to analyze major components (characters, places, tenses, events) of a given text. These components were represented as lists on each horizontal side of an interactive cube metaphor. The title of the study went on the header toolbar whereas interaction buttons for rotation, insertion and deletion controls went in the footer toolbar. Results were presented by horizontally rotating the cube which activated by a flip switch on the footer bar.


**Figure 8.** Initial Design of The Story Map Application

This initial design failed on the first usability test. Students failed to insert items on the lists, rotate the cube by selecting the categories and see the results by turning on auto rotate flip switch. These problems were tackled by a whole new interaction design with the same cube metaphor. This design eliminated the rotation radio buttons for category selection. Cube rotation was triggered by more

intuitive swipe gestures. Besides fixed top toolbar for title was removed and a new title changing system was developed. Furthermore, a single add item button was placed under the cube (Figure 9).


**Figure 9.** Second Design of the Story Map Application

Besides, a whole new results page was prepared as still flat lists on a single page rather than the animated 3D rotating cube (Figure 10). Transition between the results page and the cube page were provided via yellow buttons on the top.


**Figure 10.** Results Page of the Story Map Application

This new look and interaction design proved useful on the first design cycle following the usability test. However, this design went under minor optimizations.

The design cycle on 19.11.2014 suggested students had difficulty recognizing the add item mechanism placed under the cube. However self-explanative “click here to change the title” mechanism worked perfectly. This observation led to a new item adding mechanism. A self-explanative “click here to add element” button was placed on each side of the cube (Figure 11).


**Figure 11.** Third Design of Story Map Applicaiton

Another revision suggested by this design cycle was on the results page. Since students forgot the name of the story, expert panel decided to place the name of the story on the results page (20.11.2014). Title of the story was placed on the top of the screen, above the results lists (Figure 12).


**Figure 12.** Results Page with Title

As an habitual practice, students and teacher rotated the cube by swiping left. This practice led to an optimization on the ordering of the cube sides. Initial characters, events, tenses, places ordering was changed to characters, places, tenses, events line up to conform the participants' expectations.

Another design flaw caused by software keyboard. Since software keyboards on tablet devices push half the way up to the screen informative elements on the page became invisible to students. This left student less informed and confused about the active side of the cube (Figure 13-left). This flaw was eliminated by scaling down the cube so that the title bar stayed always visible (Figure 13-right).

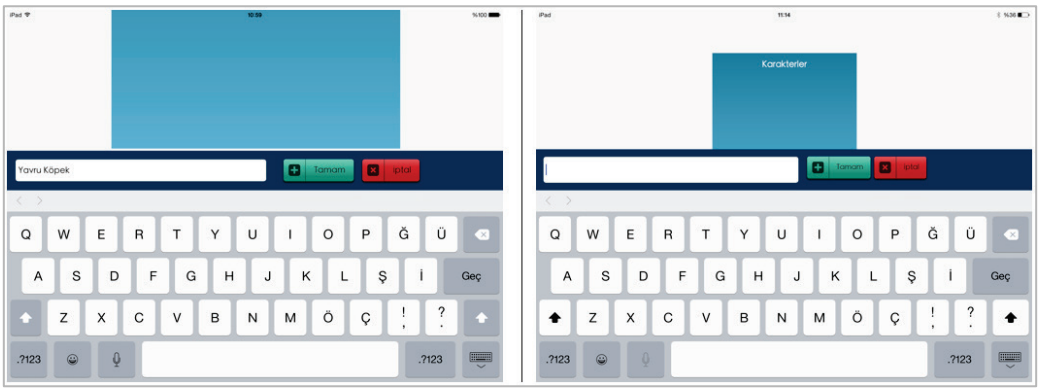


**Figure 13.** Software Keyboard Problem and Solution

The next design cycle took place at 17.12.2014. Researchers observed problems with single line list items which did not show entire content for long sentences (Figure 14- top left).

- Single line list items do not show entire content. List items should wrap the text and show multiple lines on longer sentences. (Field Note: 17.12.2014).

Another suggestion made by observing researchers was about ordering of list items and buttons. Initial design placed the add item button on the top of the list. However, this design proved fallible in the design cycle.

- Add item buttons should go under the lists. Students have difficulty touching the up most item (Figure 14- top right).

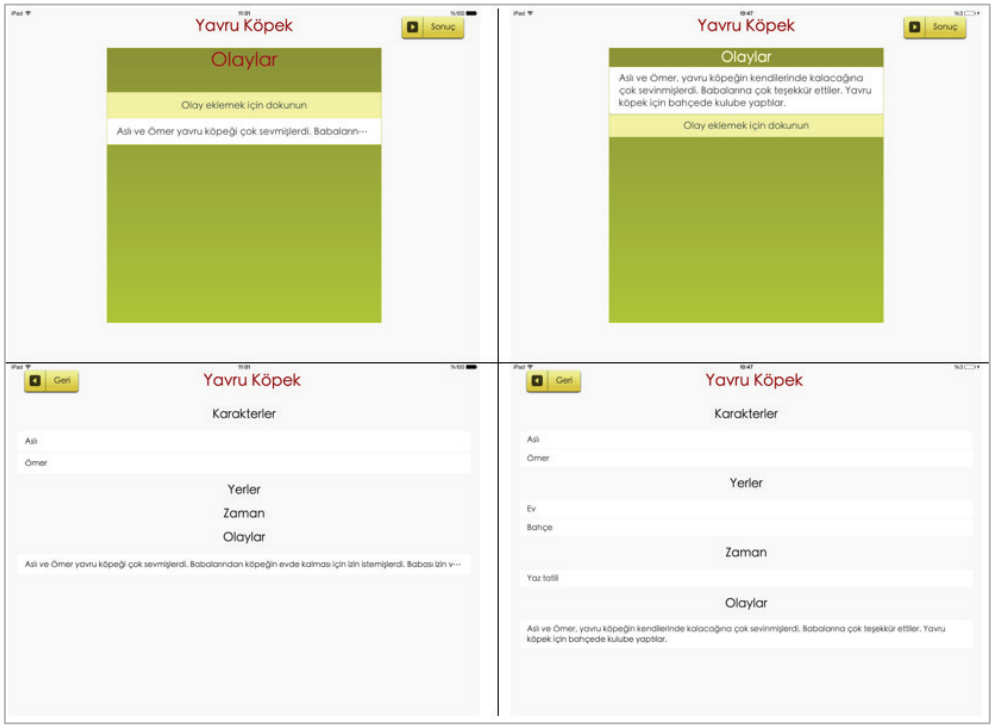


**Figure 14.** Fourth Design of the Story Map Application

The initial design did not support editing the list items. Students were required to delete the mistyped items and rewrite from scratch. Since children's typing capacities were limited, this mechanism proved time-wasting in the class.

- We can offer a toolbox for list items. This toolbox should contain edit and delete buttons.

All these suggestions were reflected to the fourth design of the story map application (Figure 14 and 15). The fourth design was evaluated on the next design cycle on 24.12.2014. This cycle did not suggest any flaws. Thus, the optimization phase of the application finished.

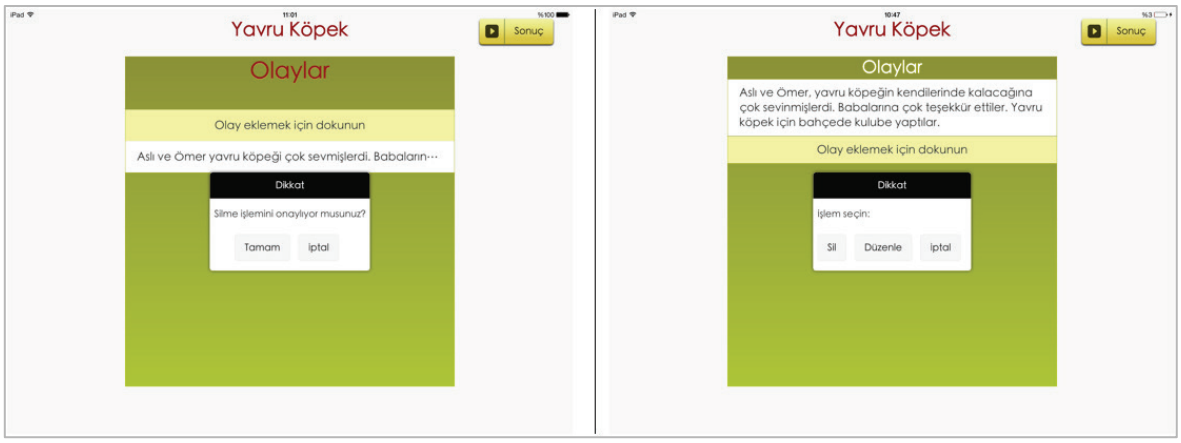


**Figure 15.** Toolbox for Editing and Deleting List Items

***Integrating Storybook into Turkish Language Classes***

Storybook application was integrated into Turkish language classes at the Spring semester of 2014-2015 academic year. These classes were investigated in the frame of a case study. A total of six classes were observed by two researchers from CEIT department. Besides these classes were videotaped which resulted in a sum of 487 minutes video footage (Figure 16).

**Figure 16.** Photos from Technology Integration Classes

Storybook application was used for reading comprehension activities in Turkish Language classes. Each session took approximately 80 minutes which accounted for two lessons in Turkish schools. These classes were taught by a senior teacher who is also a researcher in the project. All classes covered new stories (Table 7). The teacher began classes with talking about the cover page which prepared students for the new study. Then, teacher read out loud the story to the class. Following this first pass, students read out small parts of the story in turn. After the reading part, students were asked to retell the story in their own words. Students retold the story plot as much as they remembered.

Following this part, a vocabulary exercise took part. Students pinpointed the unknown vocabulary and meanings were discussed. Should no student could explain an unknown word, the teacher made necessary explanations through the text, illustrations and dramatization. Finally, students replied each question on the end of the stories.

***Integrating story map application into Turkish Language Classes***

The story map application worked in tandem with storybook. The aim of the story map application is to analyze main components in the story which are characters, places, tenses and events. Integration studies took six sessions which were investigated through the case study. These classes were taught by the same teacher following the reading comprehension activities where storybook application was used. All sessions were videotaped and observed by two researchers. A total of 236 minutes video footage and 12 field notes were produced through these sessions.

Story analysis began with writing the title of the story. Then major components of the story were identified through characters, places, tenses and events sequence. The teacher filled out each side of the cube in her own tablet. Then students were given time to insert these components into their own story cubes. The teacher reflected her own results page in the interactive whiteboard to support students.

## Discussion and Results

This paper reported a holistic mobile application integration study into hearing impaired students' literacy classes. Two distinct but integrant mobile applications built up from scratch and optimized with hearing impaired students. Finally, these applications were utilized in Turkish language classes through the course of a six-week case study. This case study investigated affordances and utilization guidelines of mobile applications in hearing impaired classes.

Even though a very innovative technology introduced to the class, teacher relied on fool proof activities that was second nature to the ICEM and students. Mobile applications generally substituted pen and paper and mainly stimulated students' motivation in the class. An overview of classroom activities resulted in a four-step integration model (Figure 17).

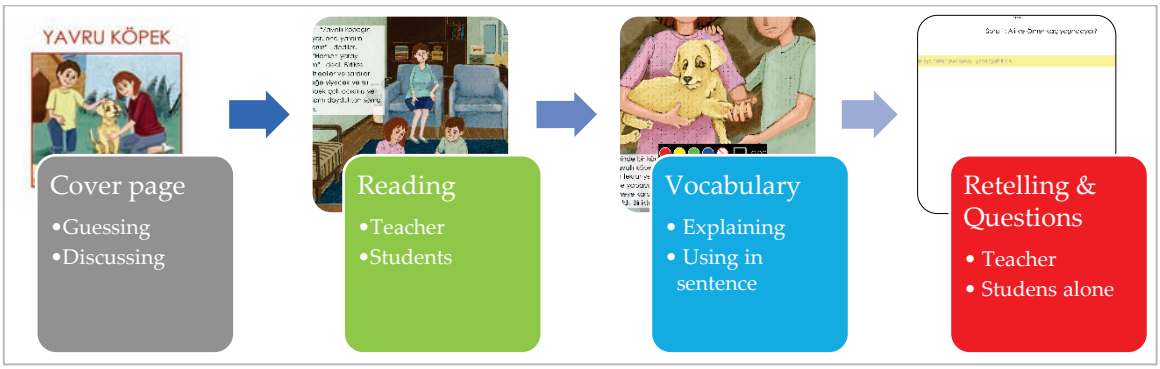


**Figure 17.** Integration Steps for Storybook Application

Reading comprehension activities started with inspecting the cover page. Teacher had students discuss on the cover page and encouraged them to guess the theme of the story. This activity prepared students for the story by stimulating their attention. The second step covered reading sessions. Teacher began the step by reading aloud the story. This first pass required students to listen and track the teacher's progress on text which was beneficial for their delayed reading skills (Woods & Moe, 2007).

On the second pass, students read aloud the story in turns. This pass allowed teacher to monitor the students' reading and fix their misspellings as they came out (Chaleff & Ritter, 2001). The third step involved retelling the story. This activity is well established in reading classes which fosters students' comprehension. Besides, retelling allows teachers to inspect the class' comprehension and fix any misunderstandings should they come out (Caldwell & Leslie, 2005; Reutzel & Cooter, 2007). Without clues from the comprehension evaluation activity, the students should be told the text they read beforehand in order to reach the knowledge they remember, what they understand about the characters, the events and the topic of the emulation, and then the questions of comprehension should be asked. (Woods & Moe, 1989).

The last step covered vocabulary and questioning activities. Any unknown vocabulary were collectively identified and described in the class. Vocabulary in an instructional story must be carefully organized. The story should introduce a few unknown words which students can easily infer from the text (Temple, Crawford, & Gillet, 2009). Teacher began this step by tracking the text for new vocabulary. Initially teacher asked students to explain the new words by their own experiences or through inferring from the text. Students explained and used these words in their own sentences. However, teacher had to interfere the activity in cases students failed to explain or miss-explained the words. Finally the step ended with answering prescribed questions at the end of the stories. These questions required students to memorize components (eg. name of the characters or places) in the story, explain the events, make deductions (eg. characters' feelings about events) and interpret the story (eg. what if scenarios, what should have done about sth.) in the light of their own experiences (Applegate, Quinn, & Applegate, 2002). These questions were first answered collectively in the class through discussions. Then teacher allowed students to type in their answers into the tablets. Meanwhile the storybook application was projected on the interactive whiteboard to support students as they type.

The story map worked in tandem with storybook application. This application required children to memorize and analyze certain elements in the stories (Finney, 2003). In line with expert views these elements are title, characters, places, tenses and events of the story. Students were asked to memorize and analyze these elements in stories. Identified items were inserted into lists located on the sides of the cube. These analysis activities help students to comprehend the text by requiring them to identify textual elements and understand textual structures (Zwiers, 2004). Story map activities completed within five steps (Figure 18). All activities were repeated twice. On the first run teacher worked with class and populated the lists. The second run required children to type these items into their own tablets.


**Figure 18.** Integration steps for story map application

Even though the story map activities took place after the story book activities, students used both activities simultaneously. Students had to switch between two applications to analyze and identify items. The first step to story map application is to type in the title of the story. The second step is to identify all characters in the story. The characters in the story varied from plants to animals and children. The third step is to identify important places where major events of the story happened. The fourth step covers the tense analysis activities. Hearing impaired children have difficulties in these analyses due to their delayed oral language and agglutinative nature of Turkish Language. Finally, the last step to story map activity is identifying major events in the story. Activity ends when all the students finish populating lists on their own tablets.

Technology integration literature targeting hearing impaired children is rather thin (Lidström & Hemmingsson, 2014; Liu et al., 2013). Most of the scholarly articles report sign language applications. A few studies report technology-rich material development procedures.

This paper reports the whole integration process of mobile reading comprehension applications for hearing impaired children. In parallel with Dangsaart et al. (2008), results suggested increased attention and motivation towards technology-rich literacy classes. There is need for increasing the quantities and qualities of studies related to hearing impaired children. These studies should collect experiences from various disciplines, focus on literacy skills rather than supportive presentations (e.g. sign language) and report the integration procedures holistically. Further research should examine affordances of mobile applications for hearing impaired classes through other research approaches. Researchers believe guidelines and procedures reported in this study will be beneficial for further endeavors.

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