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The Effect of Graphic Symbol Learning Environments On Verbal Problem Solving Skills Of Hearing-Impaired Students

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Abstract: Alternative communication means based on graphs such as photos, drawings and picture symbols could be used effectively for hearing- impaired people, but the literature provides few of such examples. Present study investigates the effectiveness of graphic symbol learning environments in problem solving skills of 4 hearing impaired students at elementary 3rd grade. The researchers made a problem pool of 22 items on add subtract. 5 of the problems were selected from the pool to give the students a test. In this way, the participants' verbal problem solving skills in add subtract were defined in pre- test. Next, the problems were presented in graphic symbols. Each of the sentences in presentations was converted into graphic symbol sentences. It was followed by reading and understanding the problem, discussing given values, students' noting the problem statement on notebooks (including graphic sentences of the verbal problem only), and the teacher/student solved the problem on the whiteboard. In the end of the practices, the pre test verbal problem was given again after modifying the numbers. It was found in pre tests that the students added all of the numbers in a column. On the contrary, the participants could determine which steps they should do subsequently for each problem in the post test.

Keywords: : graphic symbol, hearing impairment, mathematics, verbal problem.

Graphic symbols are considered alternative communication means for individuals with language and learning deficiency. Symbol cards, symbol boards/pointing boards, and drawing templates are expressed as traditional methods of graphic symbols in learning environments (Glennen and Decoste, 1997). Besides, graphic symbols are used to create learning environments meeting individual needs by being integrated with information and communication technologies and to help gain many upper level skills including reading and writing (Waller and Jack, 2002; Merwe and Alant, 2004; Takasaki, 2006; Marcus, 2007; Dada and Alant, 2009).

Graphic symbols, though used for various groups of special training such as the physically disabled, the retarded, the multiple disabled, the autistic, paralyzed adults and the speech handicapped, is not widely used for hearing-impaired individuals, who represent a considerable part of the population in need of special training (Hourcade, Parette, Boeckmann and Blum, 2010). In their review carried out on using of graphic symbols for the hearing-impaired, Davis, Barnard-Brak, Dacus and Pond (2010) found out only six studies based on symbolic graphics such as photograph, line drawing and words between 1971 and 2009. On the other hand, related literature provides evidences that graphic symbols are used efficiently for enhancing development of vocabulary and reading-writing training (Whittle and Detheridge, 2001; Inaba, Takasaki and Mori, 2006; Parette, Boeckmann and Hourcade, 2008; Sheehy and Duffy, 2009), cognitive capability of the hearing-impaired is comparable with that of normally developing peers (Ansell and Pagliaro, 2006), and majority of the hearing-impaired did not have reading-writing skills comparable with their peers at graduation from high school (Zernovoj, 2005).

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Hearing-Impaired Individuals and Graphic Symbols

Graphic symbols are considered to be materials stimulating visual intelligence for most individuals needing special training. It is studied whether or not graphic symbols can be used as a means of learning or communication for various populations of the hearing-impaired.

Heller and others (1994) investigated the effect of communication boards comprised of black and white line drawings on students with serious hearing and vision impairment. Their study focused on experiences in using individual communication boards of three high school students using the sign language who are enrolled in vocational training programs. The research revealed that the communication boards helped participants give correct answers in all of the three social communication activities. The students could respond accurately via their own communication boards to their interlocutors communicating via their boards.

Cohen, Allgood, Heller and Castelle (2001) examined the effect of picture dictionaries on communication skills of vocational training students with hearing and mental impairment. For the study sample, they identified three students who are able to use sign language as basic means of communication, have limited writing skill, are able to copy written messages and have experience with symbol-based systems. Customized picture dictionaries containing symbols as well as corresponding words or phrases were designed for each student. During the implementation, data were collected about methods used for communication by students (picture dictionary, symbol communication board, writing note, gesture, and mark), content of the message they transmitted, whether the communication was started by student and missed communication opportunities. Data analysis showed that the students benefited from the picture dictionaries effectively in order to express themselves. It was understood that the students preferred picture dictionaries for taking notes in most of the communication opportunities among all other communication methods.

Another study was carried out by Zaman, Zainuddin and Ahmad (2009) with three hearing-impaired students, one male and two females. In the study, the topic of microorganisms was taught with activities by using pictures, sign language, finger alphabet and texts in science class. As a result, it was seen that hearing-impaired individuals were more skilled in recognizing pictures and texts than sign language and finger alphabets, they could recall texts in a longer period than pictures.

Çiftçi (2009) researched 17 students' skills of making sentences and using tenses properly at 9th grade in Girls' Vocational School for the Hearing-Impaired. First, the students were shown a cartoon film and asked to express it in writing. Study data were analyzed and it was seen that the students had problems with making sentences, using tenses properly in sentences, building up meaningful sentences, choosing correct words and spelling. Afterwards, some sentences were selected as examples to be used for narrating the cartoon they watched. Subject, object and verb pools were formed in a way presenting selected sentences. In the material developed, subjects and objects were represented by graphics and verbs were represented by buttons containing animations. The students were allowed to make meaningful sentences related with the cartoon they watched by pressing correct buttons. As a conclusion, the study revealed that the material consisting of graphics and animations has a desirable effect on students' skills such as making up sentences and using appropriate tenses in sentences.

Şılbır (2011) carried out studies for teaching Turkish as an agglutinative language to individuals with hearing impairment. He selected certain Turkish suffixes (accusative (-i), dative (-e), locative (-de) and ablative (-den) of cases of nouns; present continuous (-yor), future (-ecek) and past (-di) of tenses) and prepared visual representations for selected suffixes. The system was called GÖRYAP comprised of graphic subcomponents and provided to 14 students from 6. 7, and 8th grades. Activities were carried out for learning of agglutinative structure of Turkish with this system. As a result, graphic symbols used in

learning activities were found to contribute to boost hearing-impaired students' vocabulary and teach them affixes in Turkish.

Hearing-Impaired Individuals and Mathematics

Ansell and Pagliaro (2006), in their study carried out with approximately 90 % of the K-3 teachers from 5 schools for the hearing-impaired, asked how often they made available story problems for their students and by which communicative means. Questionnaires were given to participant teachers. 7 of the participants were deaf, 3 had hearing impairment, and 26 of them did not have any hearing impairment. Analysis of collected data showed that the teachers rarely used story problems. As a conclusion, the study put forth that students with hearing impairment were not provided story problems early or often enough, hence they could not have opportunities for building strong problem solving strategies.

Kelly and Gaustad (2007) investigated the relationship between mathematics achievement and reading, language and English grammar skills of university students with hearing impairment. Standard tests were used to determine students' mathematics, grammar, vocabulary and reading skills. Data analysis yielded that proficiency in certain morphological structures in English has a significant relationship with mathematics besides reading skills level. The findings of the study indicate that achievement in advanced mathematics teaching can be reached only by acquisition of morphological knowledge and skills concerned with formation of English vocabulary.

Research suggests that reading-writing skill is fundamental for acquiring of many other higher level skills and thus incomplete learning of it affects quality of the other learning outcomes. Researchers investigating teaching of mathematics to the hearing-impaired place emphasis on the suggestion that such individuals' achievement in mathematics depends on their linguistic skills (Blatto-Vallee, Kelly, Gaustad, Porter and Fonzi, 2007; Pagliaro and Kritzer, 2013). Researchers put forward that building blocks of language should be taught in a systematic way in order to be able to teach advanced mathematics to those with hearing impairment (Kelly and Gaustad, 2007). Also it is pointed out that hearing-impaired individuals' performance in solving mathematics problems is determined by challenges they face in reading and understanding written texts, and the way of presenting the contents has influence on overall process (Ansell and Pagliaro, 2006; Lee, 2010). In addition, it is stressed in the literature that development of academic performance of such individuals depends on teachers' developing and using better strategies in class activities (Albertini, Kelly and Matchett, 2012). Bearing this in mind, the research was carried out in an attempt to answer the question 'Do verbal problems made readable with graphic symbols have a positive effect on hearing-impaired students' performance in solving verbal problems?'

Method

This is a mixed methods research employing both qualitative and quantitative data collection methods since mixed research allow combining advantages of both approaches (Sale, Lohfeld, and Brazil, 2002; Creswell, 2006; Teddlie and Tashakkori, 2011; Baki and Gökçek, 2012). Mixed research pattern makes available to researchers an increased number of methods and techniques and allows using multiple approaches while seeking answer for research question (Johnson and Onwuegbuzie, 2004; Bryman, 2006). Mixed method was used in this study since it was considered suitable for the nature of this study (Hanson, Creswell, Clark, Petska, and Creswell, 2005; Collins, Onwuegbuzie and Sutton, 2006; Fraenkel and Wallen, 2008).

In present study, learning materials were developed with the graphic symbol system called Alternative Communication System for Turkish (ALİS) and its usefulness on development of hearing-impaired individuals' verbal problem solving skills was examined. Since the study requires using of both qualitative and quantitative data collection methods, it was thought that multiple approaches can be

more useful in our study as mentioned in mixed pattern. Questionnaires, interviews and document analysis were used in order to boost reliability of data analysis.

Study Group

Study participants included students at the 3rd grade level and classroom teacher for the hearing-impaired in the Elementary School for the Hearing-Impaired. Students' demographic properties are given in Table 1.

Table 1

Demographic data of students

Student	Gender	Age	Student	Gender	Age
O1	Female	9	O5	Male	8,5
O2	Female	9	O6	Male	9,5
O3	Female	9	O7	Male	13,5
O4	Male	9,5	O8	Male	9

The implementing teacher graduated from Karadeniz Technical University, Education Faculty, Teaching for the Hearing-Impaired Department. She has 10 years' experience, and has been teaching in the school included in the study for three years. All of the activities during evaluation of the system were carried out together with the implementing teacher. Permission was obtained from Trabzon Provincial Directorate of National Education before carrying out of the activities.

ALİS Graphics and Learning Materials

ALİS is the design project of a graphic symbol system as an alternative communication system for Turkish. The project was launched in order to answer the question 'Is it possible to write Turkish with graphic symbols?' Turkish is eligible for making up graphical sentences due to its certain suffixes and core vocabulary (Karal, Aydın and Günal, 2010; Aydın, Şılbır, Küçüksüleyman, Karal and Altun, 2012).

In this study, the experts (1 classroom teacher for the hearing impaired and 2 pre-service classroom teachers for the hearing impaired) made verbal problems about add-subtract operations readable with ALİS graphics. It was aimed at find out effects of graphic symbol learning materials on students' basic mathematics skills. A pool of verbal problems with 22 items was formed by the experts. Among the items, 5 were selected and put into readable form by the teacher in charge of implementation. The problems were prepared as presentation files with each sentence coded in graphic symbols. Also the story represented with each graphic symbol sentence was illustrated and added into the presentation. An example problem expressed with graphic symbols is shown in Figure 1.

Data Collection Instruments/Techniques

Students' exam papers. The experts including the implementing teacher, one classroom teacher for the hearing-impaired, and two pre-service classroom teachers (4th grade) for the hearing-impaired formed a pool containing 22 problems of add-subtract. 5 of the problems were selected for examination by the implementing teacher. The exam paper about add-subtract operation was given as pre-test before starting of evaluation of the material. The exam paper was also given as post-test after changing the figures in questions.

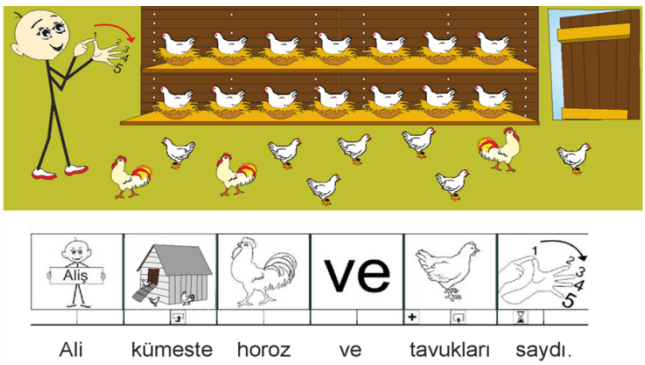

Figure 1. Example sentence and graphic symbol representation of a verbal problem

Questionnaire and Interview. Questionnaires and open-ended interview questions were given in order to find out implementing teacher's views on the system in depth. During evaluation of the system, both questionnaires and interviews were used to find out the implementing teacher's opinions regarding (1) utility of graphic symbols in learning environment for the hearing-impaired, (2) with what kind of activities they can be accompanied in classroom, (3) recommendations for teachers interested in using the symbols, and (4) recommendations regarding improving the system for effective and widespread use in special training. The semi-structured interviews including these questions were video recorded for in-depth analysis.

Data Collection Process

First of all, a written examination was administered to the 3rd grade students as pre-test in order to determine their baseline verbal problem solving skills. The examination was implemented during one lesson. Following, mathematics activities designed with graphic symbols were undertaken.

The teacher in charge of implementation carried on learning activities with graphic symbols for 20 lessons for mathematics. The teacher used the sign language for communicating with students in the classroom. In order to investigate effects of graphic-aided learning environment on students' basic mathematics skills, the implementing teacher presented verbal problems prepared with graphic symbols by using the ALİS on the overhead projector. Printed problems were distributed to the students. However, those documents included only graphics, not words themselves. The problem displayed with the projector was read and studied together with students. The values given in the problem were discussed. Afterwards, the implementing teacher waited for the students to build up the problem once vowels below graphics were deleted or the whole word was deleted except for the first letter. The teacher solved the graphic symbol problems in cooperation with students by using the ALİS. The first 3 of the problems were finalized after reading and comprehending of the problem, discussing given problem, students' noting down the problem statement/words on the documents (includes graphic sentences of the verbal problem only), and the teacher's solving the problem on the board. The students were expected to solve problem 4. Two separate problems could be dealt with during one lesson hour. As a result, 20 hours of lessons were taught on average. This procedure was applied to 5 verbal problems from the pool prepared with graphic symbols by researcher. After all these steps, the implementing teacher used a verbal problem without any graphics at all, and discovered that the students succeeded solving it.

Following completion of the application, the examination on add- subtract used as pre-test was given as post-test after modifying the numbers. The implementation process was followed by questionnaire

and interviews with the implementing teacher. These instruments were used in order to obtain views and recommendations of the teacher after approximately 2 months' experience with the students using both traditional and e-learning environment designed with graphic symbols.

Data Analysis

Due to the fact that both qualitative and quantitative methods were used for collecting data, data analysis was done with both qualitative and quantitative techniques. Students' exam papers were subjected to document analysis. The exam papers containing verbal problems on add-subtract operation and students' basic mathematics skills were evaluated at pre and post stages. Grading was made out of 100 points.

Lastly, the questionnaires and interviews, which were administered to the implementing teacher for his opinion and recommendation regarding utility of the graphic symbols in the light of his experience with the students during evaluation of the system, were analyzed with content analysis.

Findings

It was aimed at investigating effects of using graphic symbols on development of hearing-impaired students' basic mathematics skills. For this purpose, the exam paper covering add-subtract operation was given the students in order to realize students' verbal problem solving skills. The papers were analyzed and results were given in Table 2 below.

Table 2

Pre-test results

Student	Score	Student	Score
O1	0	O5	0
O2	0	O6	0
O3	0	O7	0
O4	0	O8	0

It was seen in pre-tests that all students added all numbers one under the other in each problem. Problem and solution made by participant O6 are given as an example in Figure 2.

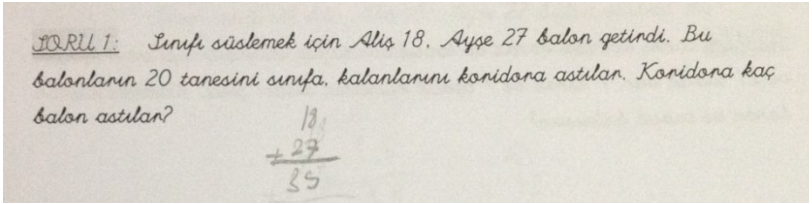

Figure 2. Sample problems and solutions used by participant O6 in pre-test

Verbal problem solving skills of hearing-impaired students were determined by using exam papers on add-subtract operations. Then, applications were performed in order to develop verbal problem solving skills of students in environments designed with learning materials based on graphic symbols. Following implementation phase of the study, the examination previously used as pre-test was given as post-test by changing numbers in questions. 4 students could not take this exam due to health reasons. Post-test results are given in Table 3.

Table 3
Post-Test Results

Student	Score	Student	Score
O1	-	O5	60
O2	80	O6	85
O3	-	O7	50
O4	-	O8	-

It was understood from exam papers that the students could identify what operations they should apply consecutively for each problem. The students' performance was found to be significantly higher than pre-test. Sample problem and solution on post-test exam paper of participant O6 are given in Figure 3.

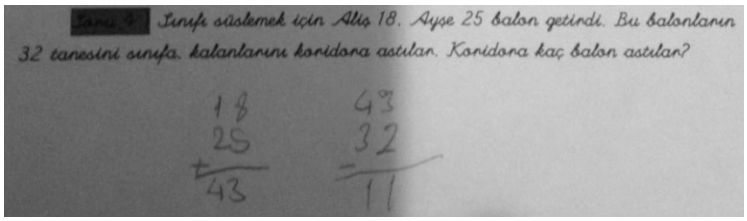

Figure 3. Sample problems and solutions used by participant O6 in post-test

The aim of the questionnaire and interviews held with the implementing teacher was to analyze effects of graphic symbols on students' problem solving skills. During applications conducted with graphic symbols, the teacher prepared and presented verbal problems by using graphic symbols.

The teacher explained that the well-developed graphic content in presentations made the activities funnier by saying '*Illustrated presentations made it funny. It was a lot of fun for them.*' As a result of the applications for improving students' mathematics skills, the teacher spoke as follows:

> 'As a result of this study, I could realize that the students did not read the problem, but they just looked at the numbers and tried to decide what to do with the numbers. But they started reading thanks to these activities. They started to be interested in reading to know what each word means due to the activities. The exams were given again by changing the numbers in problems. The students could achieve better. Successful ones did not attend the test, but those attending the test performed considerably higher.'

The teacher in implementation recommended '*Increasing number and variety of e-learning materials*' for promoting efficient and widespread use of graphic symbols for those with hearing impairment.

Conclusion

In this study, answer was sought for the question 'How do the learning materials developed with graphic symbols affect development of verbal problem solving skills of the hearing-impaired in add-subtract operations?' Those with hearing impairment do not have linguistic skills comparable with their peers (Kelly and Gaustad (2007) and the way of presenting the verbal problems has influence on hearing-impaired people's skills of comprehending and solving the problem (Lee, 2010). On the other hand, the literature provides that graphic symbols are often used for the purpose of teaching reading and writing skills. In particular, it is stressed that those needing special training have a tendency to define graphic symbols far more easily than written words (Zaman, Zainuddin & Ahmad, 2009).

There are studies carried out on normal and special individuals regarding expressing oneself by using graphic symbols, understanding what is expressed, communicating, learning words or concepts as well as producing sentences at various levels of syntactic complexity. Those studies were found to have the potential to support reading and writing skills of individuals (Koul, Corwin & Hayes 2005; Trudeau, Sutton, Dagenais, Broeck, & Morford, 2007). Furthermore, it is stressed in the literature that hearing-impaired students should be taught strategies and tools of solving verbal problems and such strategies and tools should be developed in order to help read and solve verbal problems (Zernovoj, 2005). Bearing this in mind, this study was carried out to examine verbal problems made readable with graphic symbols on hearing-impaired students' problem solving skills. Study results were found positive in consideration of expected outcomes.

It was concluded that using graphic symbols in learning environments improved the learning environment and facilitated the learning process. The activities were realized to help students read, comprehend and solve graphic symbol verbal problems, and they indicated that such symbols can be used for developing basic mathematics skills of students. In a parallel study, Berends and Lieshout (2009) investigated the effect of different types of graphics on speed and accuracy of problem solving performance of normal students. In the study, the verbal problem was presented along with a graphic to help solve it or with a graphic containing a generic picture regarding the problem not helping solve the problem. They found that using of graphics has a positive effect on academic performance.

It can be inferred that verbal problems made readable with graphic symbols contributed to students' understanding the problem. Ansell and Pagliaro (2006) underline the importance of way of presenting the verbal problems. They point out that understanding the problem statement and expression of the problem is a prerequisite for student achievement in relation with problem solving. They also suggest that teachers need to take notice of the challenges faced by students in understanding the written language and thus they should present verbal problems in a more understandable way depending on their communicative preferences. They believe that the way of presenting the problem is an important factor which could influence students' success. Findings of present study seem to justify the recommendations proposed by Ansell and Pagliaro to improve verbal problem solving skills of hearing-impaired students. As a conclusion, it can be argued that graphic symbols have a potential of increasing hearing-impaired students' achievement in mathematics.

References

Albertini, J. A., Kelly, R. R., & Matchett, M. K. (2012). Personal factors that influence deaf college students' academic success. *Journal of deaf studies and deaf education*, *17*(1), 85-101.

Ansell, E., & Pagliaro, C. M. (2006). The relative difficulty of signed arithmetic story problems for primary level deaf and hard-of-hearing students. *Journal of Deaf Studies and Deaf Education*, *11*(2), 153-170.

Aydın, Y., Şılbır, L., Küçüksüleyman, N., Karal & Altun, T., (2012). Alternatif iletişim aracı olarak türkçe için bir grafik sembol sisteminin tasarımı: standart grafik sembollerin belirlenmesi. *6th International Computer & Instructional Technologies Symposium*, Gaziantep.

Baki, A., & Gökçek, T. (2012). Karma yöntem araştırmalarına genel bir bakış. *Electronic Journal of Social Sciences*, *11*(42).

Blatto-Vallee, G., Kelly, R. R., Gaustad, M. G., Porter, J., & Fonzi, J. (2007). Visual–spatial representation in mathematical problem solving by deaf and hearing students. *Journal of Deaf Studies and Deaf Education*.

Bryman, A. (2006). Integrating quantitative and qualitative research: how is it done? *Qualitative Research*, *6*(1), 97-113.

Collins, K. M., Onwuegbuzie, A. J., & Sutton, I. L. (2006). A model incorporating the rationale and purpose for conducting mixed methods research in special education and beyond. *Learning Disabilities: A Contemporary Journal*, *4*(1), 67-100.

Creswell, J.W. (2006). Understanding mixed methods research, (Chapter 1). Available at: http://www.sagepub.com/upm-data/10981_Chapter_1.pdf

Çiftçi, E. (2009). *İşitme engelli öğrenciler için hazırlanan bilgisayar destekli yazılı anlatım becerisi geliştirme materyalinin tasarımı, uygulanması ve değerlendirilmesi*. (Yüksek lisans tezi). KTÜ Fen Bilimleri Enstitüsü, Trabzon.

Dada, S., & Alant, E. (2009). The effect of aided language stimulation on vocabulary acquisition in children with little or no functional speech. *American Journal of Speech-Language Pathology*, *18*(1), 50-64.

Davis, T. N., Barnard-Brak, L., Dacus, S., & Pond, A. (2010). Aided aac systems among individuals with hearing loss and disabilities. *Journal of Developmental and Physical Disabilities*, *22*(3), 241-256.

Fraenkel, J. R. and Wallen, N. E. (2008). *How to design and evaluate research in education (7th Edition),* New York: McGraw – Hill International Edition.

Glennen, S. L., and Decoste, D. C. (1997). *The Handbook of augmentative and alternative communication*. London: Singular Publishing Group.

Hanson, W. E., Creswell, J. W., Clark, V. L. P., Petska, K. S., & Creswell, J. D. (2005). Mixed methods research designs in counseling psychology. *Journal of Counseling Psychology*, *52*(2), 224.

Heller, K. W., Ware, S., Allgood, M. H., and Castelle, M. (1994). Use of dual communication boards with students who are deaf-blind. *Journal of Visual Impairments and Blindness*, *88*(4), 368–376.

Hourcade, J. J., Parette Jr, H. P., Boeckmann, N., & Blum, C. (2010). Handy Manny and the emergent literacy technology toolkit. *Early Childhood Education Journal*, *37*(6), 483-491.

Inaba, R., Takasaki, T., and Mori, Y. (2006, November). How do kids use pictograms? CSCW '06, Canada.

Johnson, R. B., & Onwuegbuzie, A. J. (2004). Mixed methods research: A research paradigm whose time has come. *Educational Researcher*, *33*(7), 14-26.

Karal, H., Aydın, Y., & Günal, Y. (2010). Designing a visual symbol system for Turkish language as an alternative means of communication: the process of delineating content. *Procedia-Social and Behavioral Sciences*, *9*, 679-684.

Karal,Y. (2014). *Türkçe için alternatif iletişim aracı olarak bir grafik sembol sisteminin tasarlanması, uygulanması ve değerlendirilmesi.* (Doktora tezi). KTU, Eğitim Bilimleri Enstitüsü, Trabzon.

Kelly, R. R., & Gaustad, M. G. (2007). Deaf college students' mathematical skills relative to morphological knowledge, reading level, and language proficiency. *Journal of Deaf Studies and Deaf Education*, *12*(1), 25-37.

Koul, R., Corwin, M., & Hayes, S., (2005). Production of graphic symbol sentences by individuals with aphasia: efficacy of a computer-based augmentative and alternative communication ıntervention. *Brain and Language*, *92*, 58-77.

Lee, C. (2010). *Middle school deaf student's problem- solving behaviours and strategy use*. (Doctoral Dissertation). The Ohio State University.

Marcus, A. (2007). M-LoCoS UI: A universal visible language for global mobile communication. *Human-Computer Interaction*, 144–153.

Pagliaro, C. M., & Kritzer, K. L. (2013). The Math Gap: A Description of the Mathematics Performance of Preschool-aged Deaf/Hard-of-Hearing Children.*Journal of deaf studies and deaf education*, *18*(2), 139-160.

Parette, H. P.i, Boeckmann N. M., and Hourcade, J. J. (2008). Use of writing with symbols 2000 software to facilitate emergent literacy development, *Early Childhood Educ J*, 36,161–170.

Sale, J. E., Lohfeld, L. H., & Brazil, K. (2002). Revisiting the quantitative-qualitative debate: Implications for mixed-methods research. *Quality and Quantity*, *36*(1), 43-53.

Sheehy, K., & Duffy, H. (2009). Attitudes to Makaton in the ages on integration and inclusion. *International Journal of Special Education*, *24*(2), 91-102.

Şılbır, L. (2011). İşitme Engelli Öğrencilerin Türkçe Okuma Yazma Becerilerinin Geliştirilmesine Yönelik Görsel Yardım Paketi: GÖRYAP. (Yüksek Lisans Tezi). KTU, Eğitim Bilimleri Enstitüsü, Trabzon.

Takasaki, T. (2006). PictNet: Semantic infrastructure for pictogram communication. In *The 3rd International WordNet Conference (GWC-06)* (pp. 279-284).

Teddlie, C., & Tashakkori, A. (2011). Mixed methods research. *The Sage handbook of qualitative research*, 285.

Trudeau, N., Sutton, A., Dagenais, E., Broeck, S., & Morford, J. (2007). Construction of graphic symbol utterances by children, teenagers, and adults: The effect of structure and task demands. *Journal of Speech, Language, and Hearing Research, ProQuest Health and Medical Complete, 50(5)*, 1314-1329.

Tucker Cohen, E., Allgood, M., Wolff Heller, K., & Castelle, M. (2001). Use of picture dictionaries to promote written communication by students with hearing and cognitive impairments. *Augmentative and Alternative Communication*, *17*(4), 245-254.

Van der Merwe, E., & Alant, E. (2004). Associations with Minspeak™ icons. *Journal of Communication Disorders*, *37*(3), 255-274.

Waller, A., & Jack, K. (2002, July). A predictive Blissymbolic to English translation system. In *Proceedings of the fifth international ACM conference on Assistive technologies* (pp. 186-191). ACM.

Whittle, H., and Detheridge, T. (2001). The rebus symbols development project. *Communication Matters Journal,* 15, 3, 14-17.

Zaman, H. B., Zainuddin, N. M. M., and Ahmad, A. (2009). *Learning science using ar book: A preliminary study on visual needs of deaf learners.* IVIC 2009, Springer-Verlag Berlin Heidelberg, 844–855.

Zernovoj, A. (2005). Telling, writing and reading number tales in asl and english academic languages: acquisition and maintenance of mathematical word problem solving skills. *Online Submission*.