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THE DEVELOPMENT OF MATHEMATICS LEARNING MEDIA FOR DEAF STUDENTS: PRELIMINARY IMPLEMENTATION RESULTS

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ABSTRACT

Deaf students' learning characteristics should be accommodated in their teaching and learning material. This article reported the results from the preliminary implementation of learning media for teaching mathematics to deaf students. The developed media consist of verbal and nonverbal communication, and implementation results suggested that there was students' preferential difference in responding to a particular type of communication. Further research with large scale samples is still needed to determine the effect of the media in improving deaf students' mathematics achievement and how preference in a learning mode influences mathematics achievement.

Keywords: deaf students; mathematics education; learning media

ABSTRAK

Material pengajaran dan pembelajaran bagi siswa tunarungu harus mengakomodasi karakteristik belajar seorang pelajar tunarungu. Artikel ini melaporkan hasil implementasi awal media pembelajaran matematika untuk siswa tunarungu. Media yang dikembangkan terdiri dari komunikasi verbal maupun nonverbal dan hasil implementasi menunjukkan bahwa terdapat perbedaan preferensi siswa dalam menanggapi tipe komunikasi tertentu. Penelitian lanjutan dengan sampel berskala besar masih diperlukan untuk menentukan pengaruh dari media dalam meningkatkan capaian matematika siswa tunarungu dan bagaimana preferensi cara belajar mempengaruhi prestasi matematika.

Kata kunci: siswa tuli; pendidikan matematika; media pembelajaran

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INTRODUCTION

According to the Indonesia Ministry of Social Affairs report, there were 1,648,847 Indonesian with disabilities in which 5.16% were children with hearing disability and 6.10% were children with both hearing and speech impairment (Ministry of Social Affairs, 2012). In 2012, World Health Organization (WHO) estimated that there are approximately 360 million persons with disabling hearing loss, in which 32 million are children (WHO, 2012). From studying deaf and hard-of-hearing students age 13-16, Marschark, Shaver, Nagle, and Newman (2015) found that even mild hearing loss can affecting learning achievement so that it is important to understand how to improve learning program for deaf and hard-of-hearing students.

Mathematics learning has been a subject of interest in recent research concerning learning for deaf students (for example Pagliaro and Kritzer, 2012; Vesel and Robillard, 2013; Shelton and Parlin, 2016; Ariapooran, 2017; Techaraungrong, Suksakulchai, Kaewprapan, and Murphy, 2015). Qi and Mitchell (2011) conducted an analysis of historical trends in reading and mathematics achievement of 30,495 American students in a span of three decades (from 1973 to 2003) and found that the performance of deaf and hard-of-hearing students has been consistently lower than hearing students. In terms of specific areas in mathematics, mathematical problem-solving and measurement (Pagliaro and Kritzer, 2012), numerical operations and mathematics reasoning (Bull et al., 2011) as well as word problem solving (Mousley and Kelly, 1998; Kelly and Mousley, 2001) are deaf students areas of weakness. Further, Caemmerer, Cawthon, and Bond (2016) analyzed data from 1,140 students and found although deaf students might perform better on mathematics tasks, deaf students diagnosed with a learning disability performed inferior compared to deaf students or students with normal hearing but with learning disabilities. High anxiety in mathematics and low mathematical performance was also found in deaf students (Ariapooran, 2017). In summarizing obstacles that deaf

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or hard-of-hearing persons will face, Luckner, Slike, and Johnson (2012) stated that there are five potential main consequences of hearing loss: 1) language, vocabulary, and or literacy delays, 2) gaps in background and domain knowledge, 3) inadequate knowledge and use of learning strategies, 4) social skills deficits, and 5) reliance on assistive technology. Therefore, deaf students require accommodations and modifications in their education program to achieve benefit from educational services. Such accommodation and educational program modification can be in the form of designing learning materials that can facilitate their needs and unique characteristics.

In designing learning materials for deaf students, their strength in visuospatial aspect should be put under consideration (Marschark, Lang, and Albertini, 2006) because deaf students depend more on vision than audition both in communication and in information processing (for example Marschark, Morrison, Lukomski, Borgna, and Convertino, 2013; Marschark et al, 2017). In scientific learning, Iding (2000) stressed the importance of visual displays to accompany verbal descriptions because scientific principles must be visualized to be understood. The importance of visualization should not undermine the use of verbal materials because the use of verbal and nonverbal materials enables information integration that will lead to faster learning and better retention (Presno, 1997) as well as better learning achievement (see Dowaliby and Lang, 1999). Considering these findings, in this article we reported the development of learning media for deaf students in which verbal and nonverbal materials were used in teaching mathematics.

METHOD

This study was conducted based on an ADDIE model (Analysis-Design-Development-Implementation-Evaluation). Four (4) education experts (two in mathematics and two in special education) evaluated the media in terms of content, language, display, and rubric. After three series of revisions, *the students' worksheet* -learning media in this study- was considered as valid (average evaluation score for seven validity aspects was 87.5) and ready to use in the preliminary implementation phase. The final design of the media is presented in Figure 1.

The media is consisted of verbal (textual explanation) and nonverbal (visual communication in a form of sign language pictures, scheme, diagram, and workflow). As the media was designed to specifically emphasize on visual communication, the use of text was designed to be as simple-*but clear*-as possible, while the use of sign language pictures, scheme, diagram, and workflow was maximized (Figure 1). Students' questionnaire, observation sheet, and basic competence test (verbal and nonverbal) were used to evaluate the use of the media in teaching mathematics. The basic competence test consisted of seven questions with a maximum scores of 70. Three profoundly deaf students were used as the sample in this evaluation.

RESULTS AND DISCUSSION

Students' questionnaire indicated that students preferred nonverbal learning media and evaluation to a verbal ones (Table 1). Observation to the students further affirms this preference to nonverbal mode. Students exhibited difficulties in remembering vocabulary or text-based cues. Preference over nonverbal mode also reflected in students' basic competence test results (Table 1), in which all three students performed better in a nonverbal test. Previous studies corroborated our findings in which deaf students had a significantly lower vocabulary knowledge [verbal score] (Sarchet et al., 2014), low reading word and comprehension (Kyle and Cain, 2015), vocabulary, reading accuracy and reading comprehension (Kyle, Campbell, and MacSweeney, 2016) than hearing students. Qi and Mitchell (2011) study further suggested that reading ability in deaf students historically challenging to improve.

A low score for verbal competence score mimics the finding in Kelly and Mousley (2001) studies. Kelly and Mousley (2001) evaluated deaf students ability in two type of math questions: word and graphic representation problems in which deaf students demonstrated relatively better accuracy in graphic representation problems compared to hearing students, but they find difficulties in connecting between word and graphic problems which resulted in high occurrences of computation error. Furthermore, observations on students' behavior and questionnaire in our study also suggested similar behavior patterns with students in Kelly and Mousley's (2001) study, in which students seem reluctant in dealing with mathematical word problems.

Table 1. Students' Learning Preference and Basic Competency Test Score

Students	Learning Media and Evaluation Preference	Basic Competence Test Score	
		Verbal	Nonverbal
S	nonverbal	58	59
WR	nonverbal	46	55
SRR	nonverbal	37	52
	Average	**47**	**55.3**

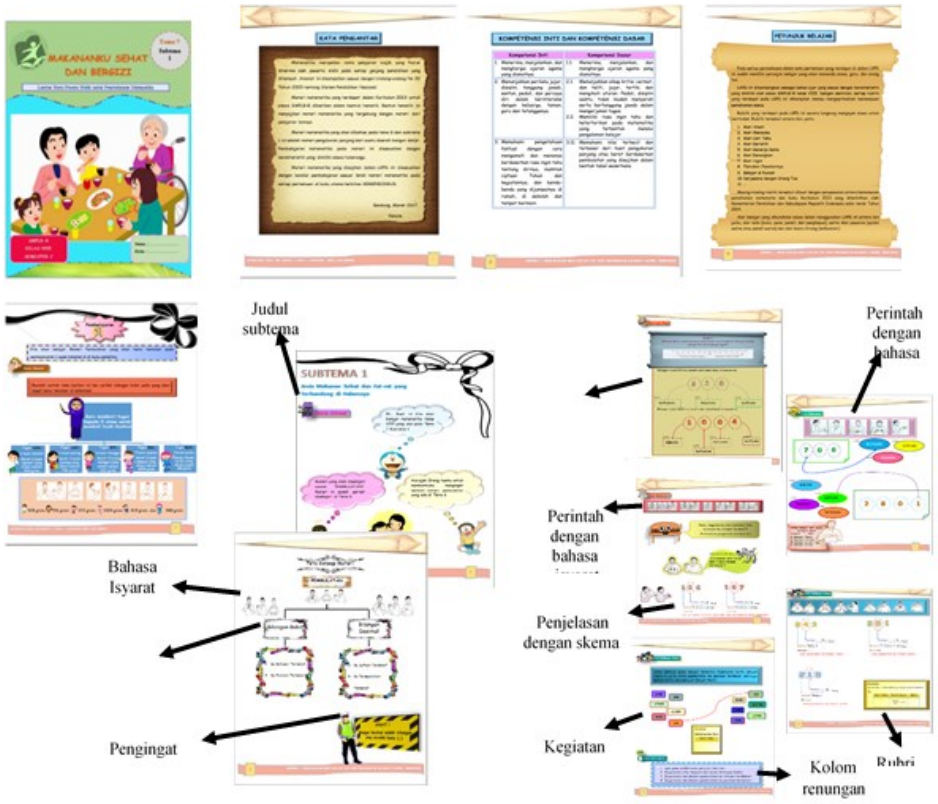

Figure 1. Mathematics Learning Media (Students' Worksheet) for Deaf Students

CONCLUSION

Preliminary implementation results suggested that deaf students preferred nonverbal learning materials and evaluation compared to a verbal one. Basic competence tests also indicated that deaf students performed better in nonverbal evaluation. Further research with large scale samples is needed to determine the effect of the use of the media in this study on deaf students' mathematics achievement and how preference in a mode of learning influences their mathematics achievement.

REFERENCES

Ariapooran, S. (2017). Mathematics Motivation, Anxiety, and Performance in Female Deaf/Hard-of-Hearing and Hearing Students. *Communication Disorders Quarterly*, **38**(3), 172-178.

Bull, R., Marschark, M., Sapere, P., Davidson, W.A., Murphy, D., & Nordman, E. (2011). Numerical Estimation in Deaf and Hearing Adults. *Learning and Individual Differences,* **21**(4), 453–457.

Caemmerer, J.M., Cawthon, S.W., & Bond, M. (2016). Comparison of Students' Achievement: Deaf, Learning Disabled, and Deaf with a Learning Disability. *School Psychology Review*, **45**(3), 362–371.

Dowaliby, F., & Lang, H.G. (1999). Adjunct Aids in Instructional Prose: A Multimedia Study with Deaf College Students. *Journal of Deaf Studies and Deaf Education*, **4**(4), 271-282.

Iding, M. K. (2000). Is seeing believing? Features of effective multimedia for learning science. *International Journal of Instructional Media*, **27**, 403– 415.

Kelly, R.R., & Mousley, K. (2001). Solving Word Problems: More than Reading Issues for Deaf students. *American Annals of the Deaf*, **146**(3), 251-262.

Kyle, F. E. & Cain, K. (2015). A Comparison of Deaf and Hearing Children's Reading Comprehension Profiles. *Topics in Language Disorders*, **35**(2), pp. 144-156.

Kyle, F.E., Campbell, R., & MacSweeney, M. (2016). The relative contributions of speechreading and vocabulary to deaf and hearing children's reading ability. *Research in Developmental Disabilities*, **48**, 13-24.

Luckner, J. L., Slike, S.B., & Johnson, H. (2012). Helping Students Who Are Deaf or Hard of Hearing Succeed. *Teaching Exceptional Children*, **44**(4), 58-67.

Marschark, M., Lang, H., & Albertini, J. (2006). *Educating deaf students: From research to practice*. NY: Oxford University Press.

Marschark, M., Morrison, C., Lukomski, J., Borgna, G., Convertino, C. (2013). Are Deaf Students Visual Learners?. *Learning and Individual Differences*, **25**, 156–162.

Marschark, M., Shaver, D.M., Nagle, K.M., & Newman, L.A. (2015). Predicting the Academic Achievement of Deaf and Hard-of-Hearing Students from Individual, Household, Communication, and Educational Factors. *Exceptional Children*, **81**(3), 350–369.

Marschark, M., Paivio, A., Spencer, L.J., Durkin, A., Borgna, G., Convertino, C., Machmer, E. (2017). Don't Assume Deaf Students are Visual Learners, *Journal of Developmental and Physical Disabilities*, **29**(1), 153–171.

Ministry of Social Affairs. (2012). *Kementerian Sosial dalam angka: Pembangunan Kesejahteraan Sosial.* Jakarta: Badan Pendidikan dan Penelitian Kesejahteraan Sosial-Pusat Data dan Informasi Kesejahteraan Sosial.

Mousley, K., & Kelly, R.R. (1998). Problem-solving strategies for teaching mathematics to deaf students. *American Annals of the Deaf*, **143**(4), 325-336.

Pagliaro, C.M., & Kritzer, K.L. (2012). 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.

Presno, C. (1997). Bruner's three forms of representation revisited: Action, pictures, and words for effective computer instruction. *Journal of Instructional Psychology*, **24**, 112–118.

Qi, S., & Mitchell, R.E. (2011). Large-Scale Academic Achievement Testing of Deaf and Hard-of-Hearing Students: Past, Present, and Future. *Journal of Deaf Studies and Deaf Education*, **17**(1), 1-18.

Sarchet, T., Marschark, M., Borgna, G., Convertino, C., Sapere, P., & Dirmyer, R. (2014). Vocabulary Knowledge of Deaf and Hearing Postsecondary Students. *Journal of Postsecondary Education and Disability*, **27**(2), 161–178.

Shelton, B. E., & Parlin, M. A. (2016). Teaching Math to Deaf/Hard-of-Hearing (DHH) Children Using Mobile Games. *International Journal of Mobile and Blended Learning*, **8**(1), 1–17.

Techaraungrong, P., Suksakulchai, S., Kaewprapan, W., & Murphy, E. (2015). The design and testing of multimedia for teaching arithmetic to deaf learners. *Education and Information Technologies*, **22**(1), 215–237.

Vesel, J. & Robillard, T. (2013). Teaching Mathematics Vocabulary with an Interactive Signing Math Dictionary. *Journal of Research on Technology in Education*, **45**(4), 361-389.

World Health Organization [WHO]. (2012). *WHO global estimates on prevalence of hearing loss: Mortality and Burden of Diseases and Prevention of Blindness and Deafness*. Geneva: WHO