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DESIGN OF MATHEMATICS AUDIOBOOKS FOR STUDENTS WITH VISUAL IMPAIRMENT AT THE SECONDARY SCHOOL

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Abstract:
This study aimed to identify the need for accessible audio mathematics books for students with visual impairment at the secondary school. The method of this research was mixed method. The sampling technique used in this research was purposive sampling, the sample consisted of 18 visual impairment students and 15 math teachers at the secondary school for children with visual impairment from 9 provinces in Indonesia. The method used in this research was explanatory survey. The instrument validity used was content validity. Quantitative data was analyzed using descriptive statistic technique. The results showed that mathematics Braille equipped with audio or vice versa (52.94%) with reason feel faster, more convenient. Subject to reduce the number of pages, then the audio book completeness tactual/Braille only in the form of illustrations and text are considered difficult course. Audio books are expected to be produced by the Daisy format (70.6%) with navigation full text and full audio (81.25%). The narrator could be conditioned, alternating between male and female, while the other musical equipment was presented as necessary. Most of the subjects wanted timbre narrator soft portion (75%), subjects considered most preferred medium tone frequency (100%). Media deviation is hoped can be stored on the thumb drive, hard drives and CDs (87.5%), while the most accessible media is a computer (53%). Level of difficulty 7th grade math book first semester of this when converted into audio format most difficult is the third part is the algebra (38.46%) and the level of average difficulty on all parts is 25.42%. If the book is converted into Braille format is in section 3 that the algebra (53.85%) and the difficulty level of the average on all sections is 27.21%.

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1. Introduction

The availability of book for the blind students at Elementary School, Junior High School, Senior High School or equivalent is not available like the sharp-sighted students. Meanwhile, all disabled (including blind) citizens have equal right to other citizens to acquire education. Every education institution should give the students equal opportunity and treatment. Justice and equal right include the availability of accessible teaching material for all blind students.

The blind students have given an opportunity of studying at any school either special (SLB) or regular school. Basically, the intelligence of blind students have interval not different from that of their peers. Although it is so, the blinds encounter some constraints related directly to their blindness' consequence. Lowenfeld (1979) states that the blind children have three main constraints: those of acquiring a variety of experiences, socializing and mobilizing. Those constraints are included into the 2013 curriculum as the special characteristics distinguishing it from other equivalent education unit curriculum.

The provision of teaching material for the blind can be in the form of teaching material in either Braille or audio format (audiobook). Both formats of teaching material for the blind students have not been available in school, moreover in audio format. When the students need to explore knowledge quickly in order to acquire necessary knowledge, Braille format cannot suffice it. Some previous studies have revealed that reading through visual channel runs more quickly than reading through tactile channel. The mean reading speed of a skilled Braille reader is 90-115 words per minutes, compared with 250-300 words per minutes for those reading visually (Simon & Huertas, 1998). It is because the blind students who have read fluently will be left behind 3-4 times in exploring knowledge compared with the normal students.

The result of survey conducted by BPMR Yogyakarta in 8 provinces: North Sumatera, West Java, Central Java, DIY, South Sulawesi, Central Sulawesi, West Nusa Tenggara, and East Nusa Tenggara about audiobook use in school, concludes that: a) about 50% of blind Special Junior High School (thereafter called *SMPLB Tunanetra*) teachers have not used learning audio media in their learning process; b) about 69.2% of blind students at SMPLB level have not used audio-based teaching material: c) about 48.7% of blind students at SMPLB want the delivery of learning material through storytelling presented in the form of monologue, drama, dialogue, and song; d) about

94.4% of SMPLB teacher and 99.74% of blind students in the 7th grade of SMPLB argue that learning audio media can motivate the students in learning (BPMR, 2014).

Considering the result of survey, it can be found that audio motivates the students to learn. The use of audio book at school is highly affected by the availability of audio book material and its hardware. The quality of audio book that has been used by some teacher is the one presenting much text and a little picture with poor configuration, for example language, social science, and story books. Audio book with many pictures, configurations, formulas (for example mathematic audio book) have not been produced yet in Indonesia. It is because of its high difficulty level compared with the book presented in text form only. The survey does not explain the type of audio book and recording format the teachers have used. Considering the author's experience of being the teacher of blind students for more than 30 years, no mathematic audio book is found or used.

The availability of audio book can improve learning independency for the blind students. Aydin & Halil (2004) state that the provision of audio electric book for the blind students in Education Open System of Anadolu University is sufficiently important to the students to learn independently anytime and anywhere they want more productively and efficiently. Aydin & Kiray (2007) conducted a research on the use of audio media for the blind students. Considering the result of research, it could be concluded that audio book used was very helpful for them to obtain their independence when they need to learn and to keep studying individually, so that they can have an opportunity of learning any lesson anywhere they want and can improve their learning ability.

Blind students have a habit of using audio modality to live daily in order to replace the function of visual modality. Audio perception is faster and broader than that on other modality. Sánchez and Flores (2004) in their study on the use of audiomath for blind students prove that the blind students benefit from the use of audiomath because they can improve their numeric memory (69th percentile score), associative memory (65th percentile score) and logic memory (3rd percentile score). It means that they perform better than or receive score higher than 69%, 65%, and 3% of other students. Finally, we can conclude that interacting with Audiomath and cognitive assignment related to the students with visual ability will develop mathematic skill and short term memory. Sánchez & Elía (ny), in their study on the blind students' learning through an interactive audio media concluded that the blind students prefer 3D or stereo audio. They get satisfaction during interaction and are motivated. The weakness of audio book use is, among others: not all students have CD player or access to internet to operate it.

2. Methodology

Overall, this study was a mixed method research (Creswell, 2009), aiming to identify the need for audio mathematic book in the first semester of 7th grade. The type of quantitative research used was descriptive one. The sampling technique used was purposive sampling one with 18 blind students SMPLB Tunanetra and 15 mathematic teachers in SMPLB Tunanetra in 9 Provinces in Indonesia being the sample of research. The method employed in this research was survey one. The type of survey used was explanatory/analytical one (Abransom, 1991). Instrument validation was carried out using content validity test estimated through examining the compatibility of the relevance of test content using rational analysis by the competent panel through expert judgment. Quantitative analysis was analyzed using a statistic descriptive technique was consistent with data frequency and percentage collected and qualitative data was used to enrich the quantitative data.

3. Result and Discussion

Table 4 shows that nearly all of teachers and students agree with the accessible, usable, portable and cheap mathematic teaching material/book. Teachers (52.94%) and students (50%) agree that the most accessible mathematic book is audio book equipped with Braille/tactual supplement or otherwise. The quality of audio book is highly affected by reader/narrator factor. Teachers (44.44%) and students (52.94%) agree that the text reader/narrator can be either male or female. The frequency of narrator's voice tone the teachers (100%) and the students (72.22%) want is the moderate tone. Timbre aspect of narrator should be soft. It is agreed by teachers (75%) and students (78.95%). In the term of sound effect aspect (the sound effect created or used to support the circumstance of act), teachers (81.25%) and students (78.95%) argue that no additional music or similar one is needed.

Table 1: Book Model Expected

Expected Condition	Teachers (%)	Students (5)
The mathematic book/teaching material model expected		-
a. Textbook read	17.65	5.56
b. Braille book	29.41	33.33
c. Audio book	-	11.11
d. Audio book equipped with Braille	52.94	50.00
Sex of book audio narrator/reader		-
a. Male	16.67	17.65

b. Female	38.89	29.41
c. Male or female is the same	44.44	52.94
Type of narrator/text reader's voice		-
a. High	-	11.11
b. Moderate	100.00	72.22
c. Low	-	-
Timbre of narrator/text reader's voice		-
a. hoarse	6.25	5.26
b. shrill	-	-
c. soft	75.00	78.95
d. loud	18.75	15.79
Sound effect		-
a. Equipped with music	18.75	21.05
b. Not equipped with music	81.25	78.95

Mathematic text book is not easily converted into audio book, as not all of content can be presented in audio form.

Table 2: Audio book and media Completeness

Condition expected	**Guru (%)**	**Siswa (5)**
Audio mathematic book completeness		-
a. Equipped with full text Braille	26.67	11.11
b. Equipped with partial text Braille	13.33	27.78
c. Equipped with only illustration/figure/formula configuration difficult to be converted into audio	60.00	61.11
d. Complement is unnecessary	-	-
Audio mathematic teaching book storage media		-
a. File in computer	6.25	10.53
b. Flash disk	-	21.05
c. CD	6.25	15.79
d. All of the three	87.50	52.63

From table 2, it can be seen that teachers (60%) and students (61.11%) recommended the audio mathematic book to be equipped with Braille/tactual supplement, but only in the parts difficult to be converted into audio format. Audio mathematic book is the most practical one, as it can be stored in file/computer, flash disk, CD or the three of them. Teachers (87.5%) and students (52.63%) argue that audio mathematic book can be stored in three media: file/computer, flash disk, and CD. Those three media can be operated automatically in computer (teacher 53.94% and students 40%).

The audio book expected is not different from the one used by other students, so that the book has standardize content, and the difference lies on its presentation only.

The result of survey on book type and the modification of audio book presentation is as follows.

Table 3: Audio Book Presentation

Mathematic text book converted into audio book		-
a. Mathematic Student Worksheet	-	9.52
b. Mathematic Dictate from teacher	5.56	4.76
c. Mathematic book prevailing regionally	5.56	14.29
d. Mathematic book used nationally and has been selected by BSNP	88.89	71.43
The presentation of Mathematic audio book		-
a. Following the original text presentation	6.25	23.81
b. Corresponding to the original text with modification according to the blind students' characteristics	81.25	76.19
c. Modified without removing the original meaning	12.50	-
The synchronization of mathematic audio book you expect		-
a. Only voice is available	6.25	21.05
b. A little text and voice are available	12.50	21.05
c. Text and a little voice are available	-	10.53
d. Full text and full voice are available	81.25	47.37

Table 3 explains that teachers (88.89%) and students (71.43%) recommend the referral to standardized book recommended by BSNP. Book reading technique, according to most teachers (81.25%) and students (79.13%), is adjusted with original text with modification corresponding to the characteristics of blind students. If audio book can be stored digitally, it gives an opportunity of creating a variety of variants. The variant with which the teachers (81.25%) and the students (47.37%) agree is the audio mathematic book appearing in full audio and full text format, thereby accessible to low-vision category of blind and dyslexic students.

Mathematic audio book in this research was equipped with tactual/Braille supplement in order to synchronize text, audio, and tactual aspects needed. Considering the result of survey, the following result is obtained.

Table 4: Tactual/Braille Supplement

Expected Condition	**Teacher (%)**	**Students (5)**
Tactual/Braille supplement has better result when it is printed through		-
a. Reglet	-	-
b. Braille typewriter	-	-
c. Braille printer	100.00	100.00
The most comfortable size of Braille paper is…		-
a. 8 1/ 2 x 11	81.25	68.42
b. 11″ x 11½	12.50	15.79

c. Others	6.25	15.79
The good weight of Braille paper is…		-
a. 100-130 mg	6.25	15.79
b. 140-150 mg.	87.50	84.21
c. More than 150 mg	6.25	-
Braille text is presented in format….		-
a. Full Braille writing	100.00	57.89
b. Partial short writing	-	36.84
c. Full short writing	-	5.26
Tactual BSA Supplement is presented as follows.		-
a. Integrated into its audio book	81.25	94.74
b. Separated from its audio book	18.75	15.79
Tactual BSA Supplement is presented as follows.		-
a. All of texts are converted into Braille/tactual form	12.50	15.79
b. Some of texts are converted into Braille/tactual form	12.50	15.79
c. Only texts difficult to be converted into audio are converted into Braille/tactual form	75.00	78.95

As aforementioned, mathematic audio book should be equipped with Braille/tactual supplement. Braille/tactual supplement, according to 100% of teachers and students, are printed using embosser or Braille printer, with paper size 11" x 12" (81.25% teachers and students 68,42%). If the paper is thin, the print out result would damage easily; if it is too thick, it could damage the printer, so that teachers (87.5%) and students (84.21%) recommend the tactual/Braille supplement to be printed on 140-150 mg paper. Indonesian Braille system contains full writing, partial, and full systems. For the Braille supplement in this research, teachers (100%) and students (57.89%) recommend the use of full writing to present this supplement. Some students want the short writing system but 100% teachers want the full writing system. It is because most teachers and a few students do not master Braille short writing.

Mathematic Audio Book and supplement is recommended to be integrated (81.25% teachers and 94,25% students). It is integrated meaning that that Braille audio book and supplement should be used concomitantly rather than in separated manner.

Table 5: The presentation of tactual/Braille supplement

Expected Condition	Teachers (%)	Students (%)
The presentation of tactual/Braille supplement		-
a. Non-modified textbook	18.75	10.53
b. Modifying textbook/Braille according to the students' characteristic and material when necessary	75.00	84.21
c. Developing distinctive tactual/Braille model	6.25	15.79
Tactual supplement of book using Braille symbol		-

a. Braille used by students	18.75	14.29
b. Indonesian standard Braille	81.25	80.95
c. Braille prevailing in an area	-	4.76

This supplement to tactual audio book can be Braille text, relief illustration (teachers 69.75% and students 71.43%). Tactual supplement as the supplement only complements and serves to clarify the content of material converted into audio format, so that all of those text are unnecessarily edited in Braille/relief illustration/tactual picture, but just the material converted into audio form difficultly. It is agreed by teachers (75%) and students (78.95%). Regarding the presentation of tactual/relief illustration/picture/Braille teachers (75%) and students (84.2%) agree to modify it in order to be observable/touchable well by blind students. The other standard used in Braille/tactual writing refers to Indonesian Braille, rather than the one used by many students and prevailing in their own areas. It is agreed by teachers (81.25%) and students (80.95%).

Table 6: Tactual/Braille supplement paper

Expected Conditions	**Teachers (%)**	**Students (%)**
Type of paper for tactual supplement of mathematic audio book		-
a. Braillon	100.00	80.95
b. HVS	-	14.29
c. Carton	-	4.76
d. Ivory	-	-
e. Duplex	-	-
Tactual supplement of mathematic audio book is more accessible when it is bound with ….		-
a. Wire (staples)	18.75	9.52
b. Spiral	81.25	76.19
c. Thread	-	9.52
d. Hot glue (perfect Binding).	-	4.76
The good Tactual supplement of mathematic audio book can be:		-
a. Text	-	-
b. Relief illustration	31.25	28.57
c. Braille text or relief illustration	68.75	71.43

Braille/tactual supplement is printed on special/Braillon paper (teacher 100%, students 80,95%). Having been printed, it is then bound strongly and usably using spiral binder (teacher 81.25% and students 76.19%).

From the result of interview with teachers and students, it can be concluded that the book needed by teachers and students is the one, the content of which is as same as

the mathematic book used by the normal students. It will facilitate the students and the teachers, particularly those attending in inclusive school. The mathematic book converted into audio format takes the text of mathematic e-books that have passed successfully through the assessment by National Standard Education Agency (BSPN). Most teachers and students state that not all materials in mathematic book can be converted into audio easily. In some difficult/complex part, it should be equipped with relief/tactual illustration and or Braille writing. Tactual/Braille illustration should be understandable, touchable, simple, and selected specifically in the parts considered as difficult.

4. Conclusion

The blind students can be optimized for their potency through learning utilizing a variety of accessible media. Audio book can reduce disabilities (limitations) the blind students experience due to direct consequence of their blindness. The accessible audio book (BSA) can be produced using digital-based (daisy) technology.

Considering the data analysis in this research, it can be concluded that: 1) in designing the mathematic audiobook product for blind students, content, presentation and technical aspects should be involved; 2) mathematic audiobook should be equipped with tactual/Braille media in the parts converted into audio difficultly or in the parts considered as important to be presented in tactual/Braille media. BSA is not a panacea to deal with all of the students' problems; and 3) the two formats are presented in a unity to be used concomitantly and complementarily.

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