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Pull Out Photo Box with AR Technology in Supporting Mathematics Literacy in Deaf Crew Members

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Abstrak. Setiap warga negara memiliki hak yang sama dalam mendapatkan pendidikan yang berkualitas tanpa terkecuali anak berkebutuhan khusus tunarungu. Kurang berfungsinya indra pendengaran menyebabkan anak tidak dapat menirukan ucapan kata-kata dengan tepat dan jelas yang berakibat pada tidak efektifnya komunikasi. Penelitian ini bertujuan untuk mengembangkan *pull out photo box* dengan teknologi *Augmented reality* sebagai media visual dalam mendukung literasi matematika pada ABK tunarungu. Metode penelitian yang digunakan adalah *Research and Development* dengan model pengembangan 3D. Metode pengumpulan data yang digunakan yaitu observasi, angket, wawancara, dan instrumen tes. Instrumen yang digunakan meliputi instrumen ahli media dan ahli materi, instrumen respon guru dan siswa, serta soal *pretest* dan *posttest*. Analisis data yang digunakan adalah uji kevalidan, uji kepraktisan, uji keefektifan (uji normalitas, uji T (paired t-test), dan uji N-Gain). Subjek penelitian terdiri dari 7 siswa kelas VI di Yayasan Anak Hebat Semarang. Hasil penelitian menunjukkan bahwa penggunaan *pull out photo box* efektif dalam meningkatkan literasi matematika siswa ABK tunarungu, dengan adanya perbedaan signifikan antara kemampuan literasi matematika sebelum dan sesudah penggunaan media tersebut. Validasi ahli juga menunjukkan bahwa media pembelajaran tersebut sangat valid. Penelitian ini juga menegaskan bahwa *pull out photo box* sangat praktis terbukti dari hasil analisis respon guru dan siswa.
Kata kunci: *pull out photo box*, literasi matematika, dan tunarungu

Abstract. Every citizen has the same right to receive quality education, including children with special needs who are deaf. Lack of functioning of the sense of hearing causes children to be unable to imitate spoken words accurately and clearly, which results in ineffective communication. This research aims to develop a pull-out photo box with augmented reality technology as a visual medium to support mathematical literacy among deaf crew members. The research method used is Research and Development with a 3D development model. The data collection methods were observation, questionnaires, interviews, and test instruments. The instruments used include media expert and material expert instruments, teacher and student response instruments, and pretest and posttest questions. The data analysis used is a validity test, practicality test, effectiveness test (normality test, T-test (paired t-test), and N-Gain test). The research subjects comprised 7 grade VI students at the Anak Hebat Foundation Semarang. The research results show that using pull-out photo boxes effectively increases the mathematical literacy of deaf

ABK students, with a significant difference in mathematical literacy abilities before and after using this media. Expert validation also shows that the learning media is very valid. This research also confirms that pull-out photo boxes are convenient, as analyzed by teacher and student responses.
Keywords: pull-out photo box, mathematical literacy, and deaf

INTRODUCTION

Education is essential for human beings to fulfill and facilitate their lives. Through education, each individual can quickly help each other. Knowledge plays a role in building communication with the surrounding environment, giving birth to ideas, ideas, and awareness. The Constitution states that every citizen has the right to education. This means that the government fully supports all individuals to have an equal right to quality education, regardless of their background, including those with special needs (Jannah & Marwiyah, 2020). In the context of education, the government not only prioritizes those who have qualified abilities in general but also prioritizes people who have special needs. Therefore, inclusive education is needed, namely, education that provides equal or equal opportunities for students who have disorders commonly called Children with Special Needs (ABK), with regular students to get learning in the same place, so that in inclusive education itself there will be no discrimination because both regular and non-regular students get the same services.

Mathematics is one of the subjects that some students fear because it is often considered problematic. This is because mathematics is a subject that prioritizes the means of thinking to study something logically and systematically (Wulandari, 2020). (Arniansyah & Nasution, 2021) it was stated that mathematics has an essential role in all aspects, even in the current era of digital technology. However, many students feel that mathematics is a complex subject to understand. This is due to the many abstract concepts that are difficult for students to accept, especially for deaf students with language limitations. Deafness can be interpreted as a condition of an individual who experiences a disorder in the sense of hearing that causes the inability to capture various sound stimuli or other stimuli through hearing (Ningsih, 2018). Children with Special Needs (ABK), especially those who are deaf, need a particular approach to learning to develop their potential optimally. Poor

functioning of the sense of hearing causes children to be unable to imitate words accurately and clearly, which results in ineffective communication (Sugianto, 2022). Mathematical literacy skills support mathematics learning for people who are deaf or hard of hearing during the learning process (Ubaidah et al., 2022). Mathematical literacy, which refers to the ability to read, understand, solve, reinform, and evaluate mathematically, is carried out by deaf people during the learning process (Panglipur, 2023). Thus, mathematical literacy is essential not only for normal children but also for children with special needs. These namely children have difficulty following the learning process due to an obstacle, one of which is children with special needs who are deaf (Febrinasti & Sari, 2018). Therefore, it is necessary to find innovative methods that support the mathematics learning process of deaf students.

One of the promising technologies in this regard is Augmented Reality (AR). AR allows integration between the virtual and real worlds to create a more immersive and engaging learning experience (Leliavia, 2023). Augmented Reality can be applied as a medium that supports the learning process for children with special needs (Buliali, 2021). Utilization of technology Augmented Reality in learning mathematics can be presented visually so that it is more interesting. In this study, developing a pull-out photo box with technology Augmented Reality becomes relevant as a visual means supporting mathematical literacy in deaf children. Pull-out photo box: It is designed to create a more concrete and meaningful learning experience for deaf ABK by uniting the real world with virtual elements through AR. Based on these problems, the purpose of this study is to develop a teaching media pull-out photo box with technology augmented Reality as a visual media in supporting mathematical literacy in deaf children and analyzing the Effectiveness of the Results of Exploration of Type Learning Media pull out photo box with technology Augmented Reality as a visual media in supporting mathematical literacy in deaf children.

This research has various significant benefits. For education, this research contributes to the development of inclusive learning media that can increase the accessibility of mathematics education for deaf children. This will help create a

more inclusive and supportive learning environment for all students. Learning media pull-out photo boxes with AR technology can help educators deliver mathematics material more effectively and interestingly for deaf children. For students, especially deaf ABK, a learning media pull-out photo box can provide a direct experience by providing an active and interactive class by visualizing exciting forms and images of learning media (Wisnu Wardana et al., 2022). For researchers, this research contributes to literature related to the development of mathematics learning media for deaf children. This can be a reference for other researchers interested in developing inclusive learning media for children with special needs.

RESEARCH METHODS

The research on developing *a* pull-out photo box with augmented reality technology as a visual media supporting mathematical literacy in deaf children's recognition of the value of numbers was carried out using the Research and Development (R&D) method. The meaning of research and development is focused on the process; research does not produce objects, while development produces objects that can be seen and felt (Syavira, 2021). A 3D development model (Three D) is used in this development research. This model is a modification of the Thiagarajan model, which includes four stages called the 4D model (Four D). According to (Rofiqoh et al., 2020) said that the stages of a 3D model include (1) Define, (2) Design, and (3) Develop.

The stages used in using the 3D model (Rofiqoh et al., 2020) are as follows:

1. Define Stage

The definition stage is also called a needs analysis, whose goal is to define the development terms and the product according to its specifications (Haristah et al., 2019). The definition stage is an introduction to the concept of motion and force. According to Thiagarajan, five analyses are in the definition stage: 1) Front and Analysis (initial analysis). This analysis identifies problems in the teaching and learning process of children with special needs. 2) Learner Analysis (student analysis). In this analysis, the student's character was identified.

The target was children with special needs who were deaf. 3) Task Analysis (task analysis). In this analysis, identify the material that students need to understand. 4) Concept Analysis (concept analysis). In this analysis, identify the pull-out photo box to be developed. 5) Specifying Instructional Objectives (formulation of learning objectives). During observations related to the learning media of the material value of the place.

2. Design Stage

The next stage is the design stage. After carrying out the definition stage by considering 5 points of analysis, a product design in the form of a pull-out photo box with Augmented reality technology is produced. Furthermore, the final stage of the design is the creation of assessment measures in the form of product validation by material experts and media experts, questionnaires from student and teacher responses, and the preparation of pretest and posttest questions.

3. Development Stage

At the development stage, it is divided into two, namely, Expert Appraisal and Development Testing (Harjanto et al., 2023). At this stage of development, it begins with the manufacture of products based on the product design that has been designed. Furthermore, on Expert Appraisal, material, and media experts assess and validate the product. The results of this validation are the basis for making the first revision of the product developed to achieve the expected results. Development Testing in the form of product trial activities for children with special needs who are deaf with teacher supervision. However, before the product trial, the pretest measures students' initial ability before using the learning media. Afterward, the posttest measures students' abilities after using the teaching media provided. In the final stage, an assessment is carried out through a teacher and student response questionnaire to determine whether the learning media is good to use.

The subjects in this study are seven students consisting of 3 male students and four female students in grade VI at the elementary school level at the Anak Hebat Foundation Semarang. Meanwhile, the object of this study is a learning media for mathematics subjects using pull-out photo box learning media with augmented

reality technology as a visual media to support mathematical literacy in deaf children at the Anak Hebat Foundation Semarang.

The data collection techniques used are observations, material, and media expert instruments in the form of questionnaires, educator or teacher response instruments, student response instruments, and test instruments. The questionnaire determines the practicality and validity of the learning media developed. The questionnaires used are validation, teacher, and student response questionnaires to determine the response to learning media. Pretest and posttest instruments determine the ability before and after using learning media. Furthermore, the pretest and posttest results were carried out using effectiveness test data to assess the effectiveness of the learning media developed.

This expert validation questionnaire is used to obtain an assessment from a team of media experts related to the learning that has been developed. This questionnaire is addressed to 2 material experts and two media experts. The subject of this expert trial was selected based on academic criteria, namely media experts and material experts who are lecturers in the mathematics education study program at Sultan Agung Islamic University and one of the teachers of SLB Negeri Semarang. Validation of learning media is carried out at the product development stage. The validation results from experts are used as a reference for improvement so that the learning media becomes better. In addition, student and teacher response questionnaires are used to assess the feasibility of the learning media that has been developed. This questionnaire was given to students and teachers at the Anak Hebat Semarang Foundation to get assessments, comments, and suggestions on the learning media product. Effectiveness test data was obtained through research instruments with pretest and posttest methods to analyze the application of teaching materials for information technology-based interactive learning media in improving students' mathematical literacy in students at the Anak Hebat Semarang Foundation.

In the analysis technique, there are 4 data analyzed. First, material and media experts' validity test questionnaire data is analyzed by providing suggestions and responses through the Likert scale. This Likert scale has five points of choice: very

good, good, quite good, not good, and not good. Second, the analysis of teacher responses using data obtained from the results of teacher response instruments is processed with the score set on the questionnaire instrument: (a) Score 1 = Not Good, (b) Score 2 = Not Good, (c) Score 3 = Quite Good, (d) Score 4 = Good, and (e) Score 5 = Very Good. Third, the analysis of student responses using data obtained from the results of student response instruments is processed with the score specified in the questionnaire instrument: (a) Score 1 = Strongly Disagree, (b) Score 2 = Disagree, (c) Score 3 = Disagree, (d) Score 4 = Agree, and (e) Score 5 = Strongly Agree. Fourth, the effectiveness of the teaching media that has been developed is analyzed through the normality test, homogeneity test, T-test (paired T-test), and N-Gain test.

RESULTS AND DISCUSSION

This research was carried out on June 27 and 28, 2024, with research subjects totaling 7 grade VI students at the elementary school level at the Anak Hebat Foundation Semarang. The stages of this research include (1) The definition stage, namely the identification of characters and learning methods for deaf children and the identification of materials suitable for the child's condition. Based on this identification, it was obtained that they tend to like to communicate with friends and have fun in their world, so interactive learning media is needed to attract children's focus as a visual means. Meanwhile, from identifying the material, the results were obtained that children still have difficulty distinguishing the number of units, tens, and hundreds. Therefore, the researcher decided to choose the material of the place value of the number as the material to be used in the research product. (2) Design stage: a product design is produced as a pull-out photo box with augmented reality technology. The design process begins with designing numbers and stickers for the title box with the help of the Canva application and creating an augmented reality design using the Assemblr edu application. They were followed by printing numerical images in photos, stickers, and augmented reality barcodes. The final stage of the design is to assemble the media pull-out photo box following the design that has been made, accompanied by the preparation of a validation

questionnaire for media experts, material experts, teacher responses, and student responses. (3) The development stage is divided into two stages, namely expert appraisal and development testing. At the expert appraisal stage, the researcher validated the product design with material and media experts, namely lecturers in mathematics education, the Faculty of Teacher Training and Education, Sultan Agung Islamic University, and Semarang State SLB Teachers. Meanwhile, development testing involves product testing activities for deaf crew members. In addition, to find out the feasibility of the learning media products that have been developed, a questionnaire of material and media experts is distributed for analysis. The next step after conducting the research is to analyze the data. The thing that is done after carrying out research is data analysis or processing. The validation questionnaire of media and material experts will be tested using the validity test of the Likert scale. Furthermore, the practicality test will be tested using the results of the student and teacher response questionnaires. The effectiveness test uses the results of the pretest and posttest.

The following are the results of analyzing the validity, practicality, and effectiveness tests.

1. Validity Test Analysis

The data used is the results of a material and media experts questionnaire. The data analysis is to change the validation sheet questionnaire containing statements into quantitative data that uses score provisions. The calculation formula for the validity test is as follows:

$$P = \frac{\sum x_i}{\sum x} \times 100\%$$

(Savitri, 2019)

Information:

P = Validity (%)

$\sum x_i$ = Total respondents' overall answer scores

$\sum x$ = Total total maximum score

The results of the calculation with this formula it is then carried out by matching the validity categories in the following table:

Table 1. Validity Criteria

Achievement Percentage	Validity Criteria
$80\% \leq P \leq 100\%$	Highly Valid
$60\% \leq P < 80\%$	Valid
$40\% \leq P < 60\%$	Quite Valid
$20\% \leq P \leq 40\%$	Less Valid
$0\% \leq P \leq 20\%$	Invalid

(Sugiyono, 2017)

a. Material Expert Analysis

Table 2. Results of the Calculation of the Material Expert Questionnaire

Score Total	Mean	Score
67 71	69	92%

Based on the calculation results above, the two material experts' average total score was 69, with an average maximum score of 75. Then, a score percentage of 92% was obtained. Based on the rate of scores, the pull-out photo box learning media with augmented reality technology to support mathematical literacy in deaf children is included in the "Very Valid" category.

b. Media Expert Analysis

Table 3. Results of the Calculation of the Media Expert Questionnaire

Score Total	Mean	Score
70 64	67	89,33%

Based on the calculation results above, the average total score of the two material experts was 67, with a maximum average score of 75. Then, a score percentage of 89.33% was obtained. Based on the scoring rate, the learning medium pull-out photo box with technology Augmented Reality to support mathematical literacy in deaf crew members is included in the "Very Valid" category.

2. Practicality Test Analysis

The data used in the practical test came from student and teacher responses. The data in statements is changed into quantitative data that uses score provisions. The calculation formula for the practicality test is as follows:

$$\%N = \frac{\sum N}{N\ maksimum} \times 100\%$$

(Savitri, 2019)

Information:

$\%N$ = Percentage of each statement item

$\sum N$ = Total score

$N\ maksimum$ = Maximum number of scores

From the results of the calculation with the formula, it is then carried out by matching the practicality category in the following table:

Table 4. Practicality Criteria

Achievement Percentage	Validity Criteria
$80\% \leq P \leq 100\%$	Very Practical
$60\% \leq P < 80\%$	Practical
$40\% \leq P < 60\%$	Quite Practical
$20\% \leq P \leq 40\%$	Less Practical
$0\% \leq P \leq 20\%$	Impractical

(Sugiyono, 2017)

a. Analysis of Teacher Response

Table 5. Results of Teacher Response Questionnaire Calculation

Score Total	Mean	Score
65	64	85,33%
63		

Based on the calculation results above, the average total score from the teacher's response was obtained at a total of 64 with a maximum average score of 75, and then a score percentage of 85.33% was obtained. Based on this percentage and included in the range of $80\% \leq P \leq 100\%$, the pull-out photo box learning media with augmented reality technology to support mathematical literacy in deaf children is included in the "Very Practical" category.

In addition to filling out the questionnaire, the analysis of teacher responses was also carried out through direct interviews. Interviews were conducted to

validate the results from the quantitative data. This allows researchers to get more in-depth and detailed information on the practicality of pull-out photo box learning media with augmented reality technology. The interview results showed that the pull-out photo box learning media with augmented reality technology is efficient for use in the learning process of children with special needs for people who are deaf or hard of hearing. The teacher also strongly agreed that the media can help educators deliver mathematics material more interestingly and innovatively to improve students' mathematical literacy. The suggestions and inputs given by the teacher lie in the color of the box display. Researchers are advised to design the pull-out photo box media color with more varied colors.

b. Student Response Analysis

Table 6. Results of Student Response Questionnaire Calculation

Score Total	Score Total	Score Total
7	100%	
7	100%	
7	100%	
7	100%	
7	100%	
6	86%	
7	100%	
7	100%	98,98%
7	100%	
7	100%	
7	100%	
7	100%	
7	100%	
7	100%	
7	100%	
7	100%	

Based on the calculation results above, the average total score of each student's response was obtained, a total of 6 and 7, with an average maximum score of 7 and then a score percentage of 98.98%. Based on this percentage and included in the $80\% \leq P \leq 100\%$ range, the learning media pull-out photo box with technology Augmented Reality to support mathematical literacy in deaf crew members is included in the "Very Practical" category.

3. Effectiveness Test Analysis

a. Normality Test

The data normality test indicates whether the data sample comes from a population with a normal distribution. The decision is made based on the significance value of the test. The data is usually distributed if the significance value > 0.05 and the null hypothesis (H0) is accepted. Conversely, if the significance value < 0.05, the data is considered not customarily distributed, and H0 is rejected. The following are the hypotheses used:

H0: Normally distributed data sample

H1: Abnormal distribution of data samples

Table 7. Results of the normality test calculation

Tests of Normality						
	Kolmogorov-Smirnov[a]			Shapiro-Wilk		
	Statistic	df	Sig.	Statistic	df	Sig.
PRE	0.270	7	0.132	0.836	7	0.092
POST	0.173	7	.200*	0.922	7	0.482
*. This is a lower bound of the true significance.						
a. Lilliefors Significance Correction						

The results of the data normality test in this study are in the Shapiro-Wilk column. The significance values obtained from the normality test for pretest and posttest were 0.092 and 0.482, respectively. Since the significance value of the normality test for both data was more significant than 0.05, the null hypothesis (H0) was accepted. Therefore, based on the decision-making criteria of the normality test, it can be concluded that this study's data pretest and posttest were distributed normally.

b. Homogeneity Test

Homogeneity tests are used to check for variance similarity or to ensure that the data obtained do not come from homogeneous populations. The decision is taken if the significant value exceeds 0.05 (Sig > 0.05). The results of the homogeneity test are as follows:

Table 8. Homogeneity Test Results

Tests of Homogeneity of Variances					
		Levene Statistic	df1	df2	Sig.
Data	Based on Mean	6.757	1	12	0.123
	Based on Median	1.521	1	12	0.241
	Based on Median and with adjusted df	1.521	1	7.916	0.253
	Based on trimmed mean	6.500	1	12	0.025

The results of the homogeneity test of the research variables showed that the significant value was less than 0.05, which was 0.123. Because the Sig value < 0.05, the hypothesis is that the data come from a non-homogeneous population. Therefore, it can be concluded that the data in this study come from a non-homogeneous population.

c. Paired T-test

The paired T-test was conducted to test whether the learning media used significantly improved students' mathematical literacy skills. The hypothesis used is:

H0: $\mu 1 - \mu 2 = 0$ means that the average score of students' mathematical literacy skills before and after learning with the pull-out photo box learning media is the same.

H1: $\mu 1 - \mu 2 \neq 0$ means that the average score of students' mathematical literacy skills differs before and after learning with the pull-out photo box learning media.

The test criteria are: If Prob./Sig./P − Value < α, then H0 is rejected; if Prob./Sig./P − Value ≥ α, then H0 is accepted. The level of significance (α) used is 5%.

Table 9. Calculation Results of Paired T-test

Paired Samples Statistics

		Mean	N	Std. Deviation	Std. Error Mean
Pair 1	PRE	68.5714	7	21.93063	8.28900
	POST	87.1429	7	11.12697	4.20560

Paired Samples Correlations

		N	Correlation	Sig.
Pair 1	PRE & POST	7	0.800	0.031

Paired Samples Test

		Paired Differences					t	df	Sig. (2-tailed)
		Mean	Std. Deviation	Std. Error	95% Confidence Lower	95% Confidence Upper			
Pair 1	PRE - POST	-18.57143	14.63850	5.53283	-32.10978	-5.03307	-3.357	6	0.015

Based on the output of the Paired Samples Test, it can be known that the value is Significant. (2-tailed) = 0.015 < 0.05, then the decision is to reject H0. The

conclusion is that there is an average difference in the learning outcomes of the pretest and the posttest, which means that there is an influence on the use of pull-out photo box learning media in improving students' mathematical literacy.

d. N-Gain Test

The N-Gain test was conducted to determine the improvement of students' mathematical literacy after using the pull-out photo box learning media. The criteria for dividing the N-Gain score are as follows:

Table 10. N-Gain Score Criteria

Normalized Gain Value	Criterion	Level of Effectiveness
$g \geq 0.70$	Tall	Effective
$0.30 \leq g < 0.70$	Keep	Quite Effective
$g < 0.30$	Low	Less Effective

Table 11. N-Gain Calculation Results

Descriptive Statistics					
	N	Minimum	Maximum	Mean	Std. Deviation
N_Gain	7	0.25	1.00	0.6548	0.27398
N_Gain_Persen	7	25.00	100.00	65.4762	27.39820
Valid N (listwise)	7				

The table shows a mean value of 0.6548. When viewed from the N-Gain test criteria, the value is included in the interval, meaning it belongs to the medium category. Thus, there is an effect of improving mathematical literacy skills after learning mathematics using pull-out photo box learning media with augmented reality technology. The level of effectiveness is included in the "quite effective" category.

CONCLUSION

Based on research conducted using pull-out photo box learning media with augmented reality technology as a visual medium in supporting mathematical literacy in deaf children, it can be concluded that the media effectively improves students' mathematical literacy skills. This has been proven by the normality tests, homogeneity tests, T (paired T-tests), and N-Gain tests. The normality test results

showed that the sample data came from a normally distributed population with significance values of 0.092 and 0.482 > 0.05. The homogeneity test results showed that the data obtained came from a non-homogeneous population with a significant value smaller than 0.05, which was 0.123. In addition, in the T (paired T-test), the results of the pull-out photo box with augmented reality technology obtained significant results on students' mathematical literacy skills with a Sig (2-tailed) value = 0.015 < 0.05. The results of the N-Gain test obtained an average score of 0.6548, which showed improved students' mathematical literacy after using pull-out photo box learning media with augmented reality technology.

The results of the validity test by media experts and material experts and the practicality test of the responses of teachers and students also showed that the development of pull-out photo box media with augmented reality technology was "very valid and very practical". The validity test for media experts obtained an average score of 89.33%, while the validity test for material experts obtained an average score of 92%. The results show that the media is "very valid". The practicality test, by the responses of teachers and students, obtained the results of the average percentage scores of 85.33% and 98.98%. The percentage results stated that the pull-out photo box media with augmented reality technology was "efficient". The interview results also showed that using pull-out photo box learning media with augmented reality technology was very practical and effective for teaching children with special needs for people who are deaf or hard of hearing. The teachers also agreed that this media can help educators deliver mathematics material more interestingly and innovatively to improve students' understanding of mathematics. One of the suggestions given by the teacher is to increase the variety of colors used in the design of the pull-out photo box media box to increase its visual appeal. Therefore, the development of pull-out photo box learning media with augmented reality technology can improve the accessibility of mathematics education for children with special needs for people who are deaf or hard of hearing.

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