Single-case study: Effectiveness of multilayer model to improve vocabulary knowledge of deaf students

Yohanes Subasno[1], Imanuel Hitipeuw[2]
[1]Department of Pastoral Ministry, Sekolah Tinggi Pastoral-Yayasan Institut Pastoral Indonesia, Malang, Indonesia
[2]Department of Educational Psychology, Faculty of Psychology, Universitas Negeri Malang, Malang, Indonesia

Article Info

Article history:

Received Feb 20, 2023
Revised Apr 19, 2023
Accepted Jun 02, 2023

Keywords:

Deaf student
Multilayer model
Single subject research
Vocabulay knowledge

ABSTRACT

This study aims to determine the effectiveness of implementing a multilayer model in lesson plan (LP) to increase the vocabulary knowledge of deaf students. This study is single-subject research with an A-B-A design (baseline-intervention-maintenance). The intervention instrument used was a LP that consisted of four units, each containing four words taught using multilayers. The instrument was validated and scored 4.6 on a scale of 1-5. The subjects who participated in the study were two students with severe deafness. Two teachers and two observers were involved in this study. The data were analyzed by inspecting the graph, intracondition, and intercondition. The percentage of non-overlapping data (PND) from the inter-condition was used to indicate the effectiveness of the intervention. It was found that the mean value of PND B/A for all LP from subject-1 was 96.25%, and from subject-2 was 100%. Thus, the multilayer model is very effective in improving vocabulary knowledge. The mean of PND A/B was 93.75%, and subject-2 achieved 89.87%, which means that the subject's vocabulary knowledge is maintained even without intervention.

Corresponding Author:

Yohanes Subasno
Department of Pastoral Ministry, Sekolah Tinggi Pastoral-Yayasan Institut Pastoral Indonesia
Seruni Street No. 6, 65146 Malang, Indonesia
Email: subasno@gmail.com or subasno@stp-ipi.ac.id

1. INTRODUCTION

Generally, new students receive instruction on specific themes, such as vocabulary knowledge. In the language literature, vocabulary knowledge is an important variable contributing to overall language proficiency [1]. Vocabulary is also the first stage in learning to read and write independently. However, weak reading achievement is a problem for deaf students [2]. Children with moderate hearing loss have lower language and reading skills than children with normal hearing and mild to average hearing loss [3]. This lag has significant implications as deaf children continue their studies. Recognizing reading difficulties is necessary to implement methods to help deaf students learn to read effectively [4]. Teachers need to recognize the importance of using different strategies to strengthen their students' word reading and reading comprehension skills [5]. In addition, teachers must be able to decide when and how to hand over responsibility to students. At this stage, teachers must know how students can internalize and make sense of the newly learned literacy skills [6]. Experimental research by Subasno *et al.* [7] published in October 2022 with the title "The effectiveness of multiplex teaching method in mastering vocabulary for deaf students", prompted the research team to conduct further studies. Even though the multiplex method was declared effective in improving vocabulary mastery for deaf students, the concept initiated by Janssen has not proven whether deaf students understand the vocabulary written and indicated.

For this reason, the research team added another layer of teaching, namely the use of vocabulary in context. In addition, this research also adds learning media by utilizing media in the form of videos to express total communication. Interviews were conducted to identify needs in the scope of deaf-speech special schools (SLB) in Malang and Surabaya (East Java), Indonesia in January-March 2022 as a first step for further research. The results of the interviews stated that deaf students had difficulty in reading comprehension (understanding meaning). The experience of teachers in teaching reading to deaf students in SLB Malang and Surabaya states that vocabulary comprehension tends to be dominated by nouns. They react more easily to things that are concrete than abstract. Moreover, the vocabulary of objects is a word often found around them [8]. The challenge is how evidence-based learning strategies will be developed to increase the language literacy of deaf children utilizing residual auditory and visual access [5].

One of the essential tasks of a teacher is to find and develop learning strategies to help their students to obtain the highest achievement in reading and writing [6]. Thus, it is evident that reading interventions with appropriate strategies are needed for deaf students. The biggest challenge is understanding the purpose of reading, which is understanding the meaning and not just saying words [9]. With their hearing and pronunciation limitations, reading comprehension is a continuing problem if, from an early age, no teaching model suits their needs [10]. That situation makes deaf children face a great challenge to become proficient readers [11] Another study by Friedmann and Szterman [12] informs that deaf students learn language starting from recognizing letters in a different way than hearing students. Students with normal hearing acquire language skills from those closest to them, such as father and mother, brothers and sisters, and shows on television and radio. The more severe the deafness, the less exposure to language in the early years of their development, especially if their parents normally hear but do not understand sign language. During this critical and sensitive period, most deaf children have very limited language input [9], resulting in low language processing [13]. Other research has also found that children with limited access or who have problems processing early language input are at greater risk than children who are late acquiring input to additional languages [14].

A different strategy was implemented in deaf classes to increase reading skills to a level comparable to hearing peers. Since 2007, Janssen [15] from Bhakti Luhur Foundation in Malang has applied the multiplex method to teach reading by introducing real objects or activities. Five things presented to deaf students are pictures, signs, printed words, written language, and spoken language. The principles adopted are general to specific, and the five elements of teaching complement-strengthen each other. The researcher saw the weaknesses of the multiplex method, which did not involve total communication and application of vocabulary in context to ensure understanding, besides the inconsistency in the implementation.

In general, a SLB for deaf teachers in Indonesia has undergone special education on the various strategies needed to work with deaf learners. Many methods help regular students learn to read, but it needs to be modified for deaf-mute students [10], [16]. Researchers' observations on the practice of learning to read for deaf students conducted in several SLB-B in Malang City in the second semester of 2019 revealed that teachers did not make changes and creative-innovative efforts to help them. They tend to teach deaf students like students who can hear and rarely even prepare multimedia and teaching aids. Multimedia is essential in assisting students in learning to read and will be more optimal if accompanied by the right approach [17].

It should be realized that the times are constantly evolving and that traditional teaching methods need to be revised for educating individuals with hearing loss. The use of modern technology makes the learning process more beneficial for them [18]. Using easily accessible digital materials can support sign language learning while providing communicative learning media for deaf students [19]. Using digital video helps them understand the material's content firsthand and incentivizes deaf students to learn. Visualization through learning media is a way to tie something abstract together [20], [21].

Piaget's thinking described in "Piaget's genetic approach to reading and language development" reviews that cognitive development includes sensorimotor stages, pre-operational thinking, concrete operational, and formal operational [22], [23]. The notion of the concrete operational stage of development suggests that a child develops the ability to think about concrete things and begins to think rather abstractly. Specifically, Vida [23] states that at the concrete operational stage, the most emphasized reading comprehension skills are related to categorization and sorting. Understanding vocabulary in the form of symbols must be stressed at this sensitive stage. The theory developed by Piaget differs from the normal development of children. But in this sensitive and important period, children with hearing loss, especially those who are deaf from birth, have very limited exposure to the language [12]. They are also often called prelingually deaf, that is, those who are born deaf or who lose their hearing early in childhood before being exposed to language [24].

Linguistically, socially, and neurologically, sign language functions very similarly to spoken language. It must be recognized that sign language is an important modality that determines language teaching strategies. Deaf students can sometimes understand the form of written symbols directly while reading. However, in other cases, sign language and the interpretation are required [25], [26]. Studies that provide interventions using the 'sight word' record a significant increase in the number of words younger deaf students can identify than older students [27]. Furthermore, Enns [25] explains the formation of the concept of deaf through three forms of capital (print, sign language, and oral writing). Bilingualism is a combination of sign language and a language many people use. Bilingualism allows a deaf person to see more comprehensively. They realize that language is a system many people use and thus become aware of linguistic operations. Vygotsky believes sign language is not a unified system and has incomplete characteristics. When a deaf person uses only sign language, they are more limited. They need to be supported in using sign language [28]. This classification refers to how a deaf person learns (i.e., learning style). In the education of deaf students from elementary to high school, it is often assumed that they are visual learners. However, there is debate about whether deaf children are more likely to be visual learners than hearing children. This topic needs more in-depth research [29].

Deaf students are less accurate in estimating vocabulary knowledge than listening students, even though language lessons are delivered using sign language to them [30]. Research from Lamar University reports that there are three stages of reading in students with hearing impairments: i) Pre-reading, namely recognizing up to 100 manual signs and being able to identify at least ten print letters; ii) Context, mastering more sign vocabulary and being able to combine two or three words in communication; and iii) Integration of word meanings [31]. Differences in reading skill levels can indicate differences in children's hearing abilities. Hearing loss prevents them from obtaining spoken language input at an early stage of development. One of the causes of lagging in language skills, especially reading, is the method of learning to read that is applied. Many educators teach reading by breaking words down into syllables and letters, not whole sentences that have meaning for children [32]. Understanding the meaning of vocabulary is essential in helping students read and understand writing independently [33]. A single-subject experimental study conducted by Komaladani *et al*. [34] showed that providing teaching and special treatment could improve the ability of deaf students to acquire new vocabulary knowledge and enhance communication skills. The instructional practice offered by the practice guides focuses on making the reading comprehension process explicit to students so they can become independent in strategy selection and use. This reflects the implicit relationship between vocabulary, sentence structure, fluency, and comprehension. Teaching reading a text can strengthen understanding, which is also a strategy to improve academic language skills in writing [35].

Research on vocabulary acquisition and reading comprehension of students with hearing impairments has been conducted in many countries with different types and varieties of languages. This research includes studies in the Netherlands [36], Iran (Persia) [37], Japan [38], and Poland [26]. All studies showed that students with hearing impairment have significantly lower reading comprehension than hearing students. More specifically, deaf students were reported to have a delay of at least five years in reading comprehension [39].

Learning from the findings of research by Subasno *et al*. [7] which states that the multiplex method is effective in increasing the vocabulary mastery of deaf children, Friedmann and Szterman [12] mention a lack of language input during deaf development and responding to suggestions to explore reading learning strategies [9], [15], [40], including the use of technology and digital media [18], [21], [41] researchers designed a multilayer model to improve vocabulary understanding of deaf students. The multilayer model combines six layers of teaching consisting: i) Concrete or imitation objects (including pictures); ii) Sign language; iii) Writing; iv) Pronunciation; v) Digitally total communication; and vi) Associative-contextual.

2. RESEARCH METHOD

This study belongs to the group of experimental research in which a small number of people are studied as subjects. This research is also called a small-n experiment, which aims to determine the causal relationship between the independent and dependent variables [42], [43]. The dependent variable was measured repeatedly based on a certain period or periods. The causal relationship between variables was found by comparing different conditions on the same subject [42], [44], [45]. The conditions in question are baseline and intervention. A baseline is a point at which the target behavior is measured before the intervention. An intervention is a condition in which the target behavior is treated and measured during the treatment. This research was designed using A-B-A (baseline-intervention-maintenance) design. Maintenance is a condition after no longer being given treatment and measuring the target behavior again [42], [46].

The research subjects were two students with severe hearing impairment (who have hearing loss above 70 dB) and reading ability far below their peers with normal hearing. Subject-1, 12 years old, deaf from birth with a deafness level of 110 dB for the left ear and 112 dB for the right ear. He was in the first grade at the Special School of Yayasan Pembinaan Anak Cacat (YPAC) in Malang. Subject-2, eight years old, had severe hearing loss with a deafness level of 103 dB for the left ear and 108 dB for the right ear. He was also in first grade but in a different school, Bhakti Luhur, Malang. This study involved two special education teachers; each had a special education teaching certificate and two experienced observers in fostering children with special needs.

This research procedure is: i) Baseline phase (A), assessing the student's ability to read vocabulary in natural conditions, without intervention. The assessment was carried out using a checklist instrument. If he cannot do it at all, the layer for specific vocabulary is marked (-); if he can perform the layer but it is not perfect, then he marked (+); and if he can perform the layer perfectly, then marked (++). In this phase, three assessment sessions were carried out to obtain a stable baseline for each layer on each learning material; ii) Intervention phase (B), the teacher taught using an instrument in the form of a lesson plan (LP). The intervention was carried out from Monday to Thursday for five weeks (five sessions), where each session was taught one LP with a duration of 90 minutes. For each teaching layer, observations were made to measure the abilities achieved by the subject. If he cannot perform the layer, he was given a score of 0; if he can perform the layer with help, he was provided a score of 1; and if he can perform the layer without assistance, a score of 2 was given; and iii) Maintenance phase (A'), the researcher measured the ability to comprehend vocabulary in the conditions after the intervention, to know whether the achievement of the abilities obtained in the intervention changed or was maintained. The measurement was done twice with the same instruments as in the baseline phase.

Data was collected using a checklist format developed by teachers and researchers by providing clear notes and instructions. The intervention instrument was a multilayer model (modified multiplex teaching steps by Janssen [15]) as a reading learning model. This instrument had been declared valid with a score of 4.6 (scale 1-5) by three experts with a Doctor of Educational Psychology degree, a Master of Special Education degree, and a Doctor of Counselling Guidance degree. In this study, the research instrument in the form of a multilayer model was integrated into four units of LP. Each LP was given four vocabularies taught through six layers of instruction. The basis for developing this instrument was a conceptual framework based on patterns of behavior changes in the learning process of reading through four elements: i) Concrete or imitation objects (including pictures); ii) Sign language; iii) Writing; and iv) Pronunciation. The four elements were arranged sequentially as layers of learning vocabulary to gain understanding. The fifth layer was total communication which combines sign language with pronunciation. In this layer, students imitated a video on a notebook or an Android phone screen. The sixth layer combines the previous two or more layers to strengthen information processing to understand the vocabulary being taught. The level of achievement of each layer of instruction was measured. The vocabulary materials were taken from Indonesian language school subjects for the first grade, especially the reading section of themes 1 and 2 in the special school for the deaf. Within each sub-theme there were four words with the following details: "myself" (*saya*/i, *nama*/name, *laki-laki*/male, *perempuan*/female), "my body" (*mata*/eye, *hidung*/nose, *mulut*/mouth, *telinga*/ear), "my family" (*bapak*/father, *ibu*/mother, *kakak*/older brother, *adik*/younger sister), and "my house" (*pintu*/door, *jendela*/window, *meja*/table, *kursi*/chair) [7]. Visually, the multilayer model settings applied in LP-1 to LP-4 are depicted in Figures 1-4. The stages for teaching a multilayer model are described in Table 1.

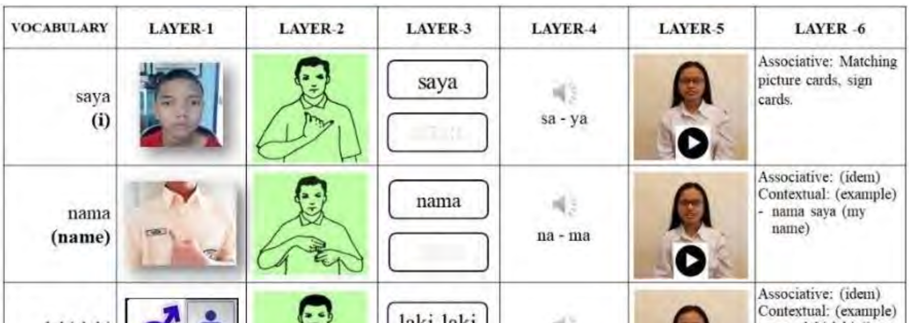

Figure 1. Multilayer model on LP-1

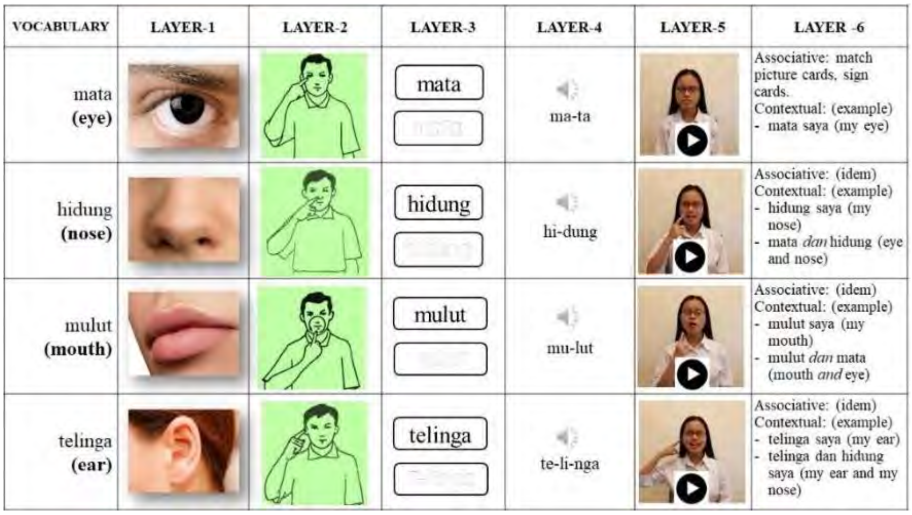

Figure 2. Multilayer model on LP-2

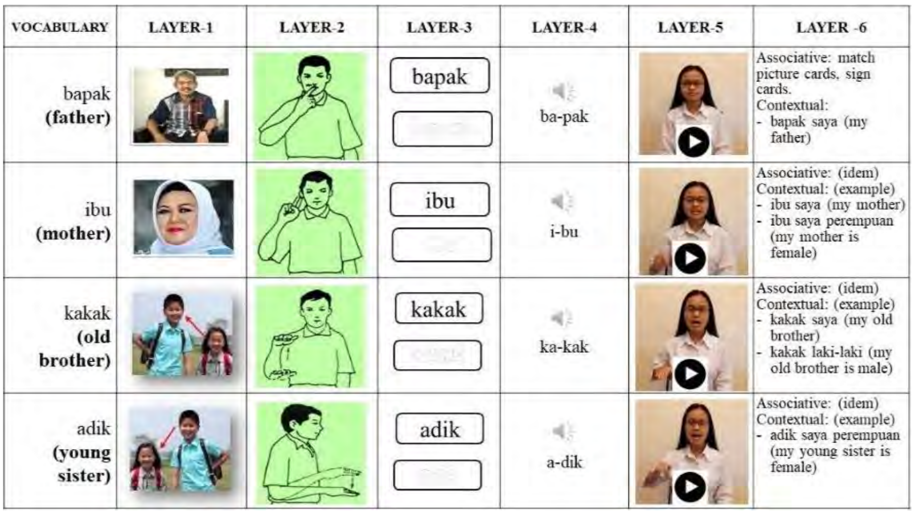

Figure 3. Multilayer model on LP-3

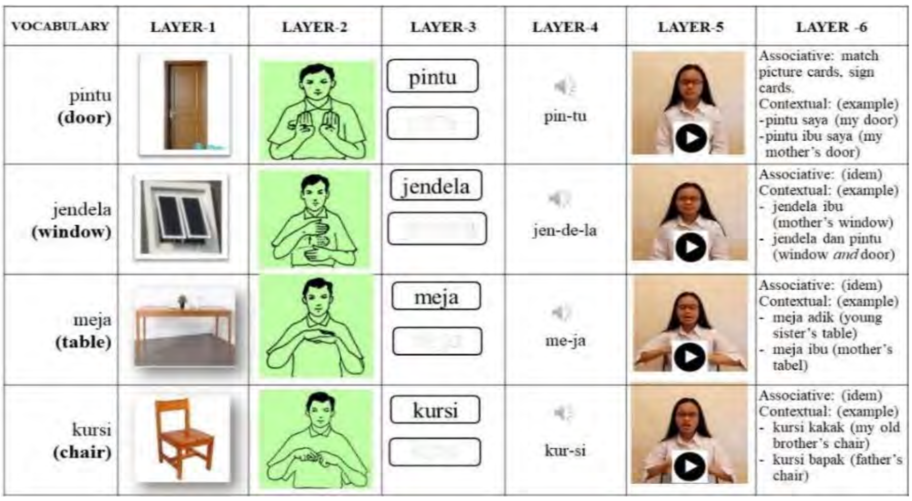

Figure 4. Multilayer model on LP-4

Table 1. Instructions on the stages of the multilayer model

Layer	Teachers' actions	Students' actions
Concrete or imitation (including pictures)	Presenting (showing, holding, touching, pointing) real objects or pictures from vocabulary while asking questions (through gestures, facial expressions, by saying "what").	Listening, observing, and expected to express something as an expression of understanding or not or even giving certain answers.
Sign language	Show concrete object or pictures, show sign language cards, signing the concrete object or pictures, and ask students to express it using sign language. The instructor can help so that students can do it on their own.	View and observe picture cards and sign language cards shown by the teacher, imitate to do sign language for the picture cards shown by the teacher, repeat until students can make sign language movements as they should.
Writing	Shows word cards of concrete objects or pictures being studied and asks students to observe. Provide writing tools and meta cards for students. Then students are asked to imitate the writing. At this step, the teacher can help students to write correctly. If students are still having difficulties, the instructor can provide dotted letters printed on the meta card for students to bold.	Paying attention to the word cards shown by the instructor, imitating the writing of the words taught on the meta card paper provided, until he gets good results. Student can first imitate dotted writing if they have difficulty.
Pronunciation	Say (pronounce) the word written on the word card clearly, with clear lip movements. Repeat several times, then it is the student's turn to say in front of the mirror. The teacher can help students by placing the back of the student's hand under the teacher's chin to feel the vibrations of the sound that 'should' be produced. Repeat a few basic articulation techniques to help students achieve optimal pronunciation.	Paying attention to the teacher's lips when articulating words, following teacher instructions and imitating speech repeatedly, even though the sound production is not perfect.
Total communication	Give an example of total communication: A combination of speech and sign language (simultaneously) of the vocabulary being taught. Ask student to imitate the examples that have been given and guide him (direct and watching form video).	First, follow the teacher's instruction, then watching the video, to combine speech and sign language (total communication) from the vocabulary taught by the teacher.
Associative-contextual	Make a matching game of picture cards, sign language cards, and word cards from the words being taught. Give examples of simple sentences (short) using the vocabulary they have learned or other vocabulary that students often encounter or do and ask students to make example sentences with the capital words they have.	Match or choose the right picture cards, sign language cards, and word cards. Make simple sentences with the vocabulary that has been learned or other vocabulary that is already owned.

The research data were converted into graphs, then analyzed visually. The visual analysis carried out included trend data, latency, and data change levels [44], [47]–[49]. Descriptive statistics in percentage of non-overlapping data (PND) were also used to analyze the same data to obtain numerical results to indicate effectiveness. PND is a manual calculation of the number of data points in intervention conditions that are outside the upper and lower limits of data in baseline conditions (no overlap), divided by all data points in intervention conditions, then multiplied by 100% [50], [51]. If the score is >90%, the style intervention is highly effective, 90%≤70% effective, 70%≤50% questionable, and <50% effective [52].

3. RESULTS

3.1. Subject-1

The score that assessed vocabulary knowledge in LP-1 is presented in Figure 5. From the four vocabularies taught, the word me immediately shows the score change in the first session of the intervention. Meanwhile, the words name, male, and female from the second to the fourth session of the intervention showed a gradual increase, then stabilized in the fifth session, even until the second session of the maintenance phase. Intervention gives the expected impact gradually (latency). The trend in the baseline phase is fluctuating for words me, stable for terms of name, male, and female but at low levels, then increases gradually in the intervention phase and fluctuates in the maintenance phase at high levels. Meanwhile, the recording of scores, including the mean, stability range, and upper and lower limits for LP-1, is presented in Table 2.

If the level of vocabulary reading comprehension for me, name, male, female, in the baseline phase to the maintenance phase when calculated, then the mean score has increased by (77.7), (75.0), (66.7), (75.0) points. PND on A/B conditions is 100% for the words me, male, female, and 80% for the word name (mean is 95%). Meanwhile, the PND on condition B/A' is 100% for the four vocabularies. The score that assesses vocabulary knowledge in LP-2 is shown in Figure 6.

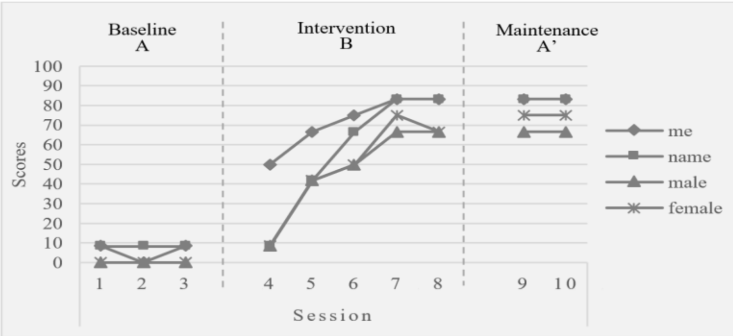

Figure 5. The score of vocabulary knowledge on each condition in LP-1

Table 2. Mean score, stability range, the upper and lower limit on LP-1

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Me	5.6	1.2	6.2	5.0	71.7	12.5	77.9	65.4	83.3
Name	8.3	1.2	8.9	7.7	56.7	12.5	62.9	50.4	83.3
Male	0.0	0.0	0.0	0.0	46.7	10.0	51.7	41.7	66.7
Female	0.0	0.0	0.0	0.0	48.3	11.3	54.0	42.7	75.0

Notes: M: Mean (M), UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

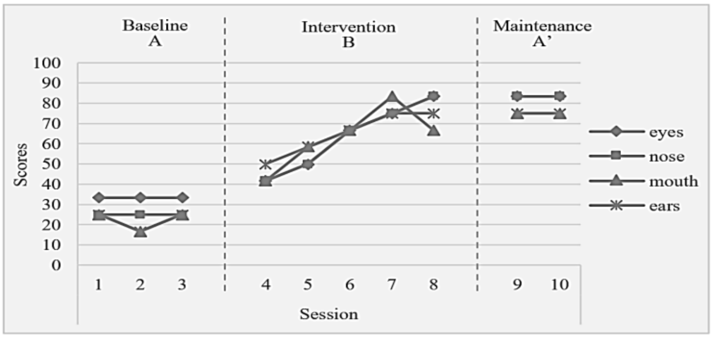

Figure 6. The score of vocabulary knowledge on each condition in LP-2

Based on the graph, the trend value for the vocabulary of eyes and nose is flat in the baseline phase, even at different grade levels. The trend increases gradually in the intervention phase, then flattens back to the maintenance phase at the highest score achievement at the time of intervention. Meanwhile, the words of mouth and ears have the same tendency in the baseline phase, which is volatile. In the intervention phase, both words experienced a gradual improvement from the first session to the fourth session. In the fifth session, word of mouth decreased, while word of the ear had sedentary grades in the fourth and fifth sessions of intervention. The increase in score from the first session to the last session of intervention indicates the latency of implementing this multilayer model to achieve a better understanding of conversion. In the maintenance phase, all four vocabularies obtained a score that settled on the highest score in the intervention phase. Furthermore, the recording of scores, including the mean, stability range, and upper and lower limits for LP-2, is presented in Table 3.

If the level of vocabulary comprehension scores of the words' eye, nose, mouth, and ear in condition-A to condition-A' when calculated in average grades, then the scores increased (50.0), (58.3), (52.8), (52.8). The PND on condition A/B was obtained 100% for the four vocabularies. Meanwhile, the proportion of data does not overlap for condition B/A'; it is received 100% for the four vocabularies. The score that assesses vocabulary knowledge in LP-3 is shown in Figure 7.

Table 3. Mean score, stability range, the upper and lower limit on LP-2

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Eye	33.3	5.0	35.8	30,8	63.3	12.5	69.6	57.1	83.3
Nose	25.0	3.8	26.9	23.1	63.3	12.5	69.6	57.1	83.3
Mouth	22.2	3.8	24.1	20.3	63.3	12.5	69.6	57.1	75.0
Ear	22.2	3.8	24.1	20.3	65.0	11.3	70.7	59.4	75.0

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

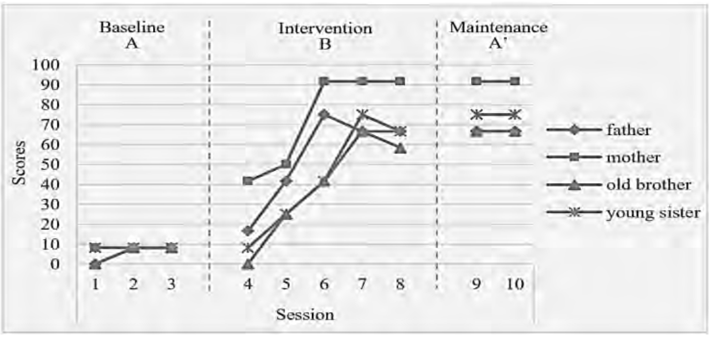

Figure 7. The score of vocabularies knowledge on each condition in LP-3

In the baseline phase, the trend of scores indicated by the vocabulary of the father and older brother slightly rose, while the vocabulary of the mother and younger sister had a horizontal trend at low levels. Entering the intervention phase, the father's vocabulary had an upward but fluctuating trend: Increasing from the first to the third intervention session, then decreasing in the fourth session, and settling in the fifth session. The mother's vocabulary, from the first session to the third session, has a sharp increasing trend, then it remains flat in the fourth and fifth sessions. Meanwhile, the vocabulary of the older brother had a score that increased from the first session to the fourth session and decreased in the fifth session. The same thing happened to the vocabulary of the younger sister. Treating the six layers has a latency element for all vocabularies, whereas the four vocabularies require two intervention sessions to have a meaningful effect. In the maintenance phase, the four vocabularies have a horizontal trend at the highest-level score achieved in the intervention phase, except for the word father. Meanwhile, statistical data on score achievement for mean, stability range, and upper and lower limits on LP-3 are presented in Table 4.

Table 4. Mean score, stability range, the upper and lower limit on LP-3

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Father	5.5	1.2	6.1	4.9	53.4	11.3	59.0	47.7	66.7
Mother	8.3	1.2	8.9	7.7	73.4	13.8	80.2	66.5	91.7
Older brother	5.5	1.2	6.1	4.9	38.3	10.0	43.3	33.3	66.7
Younger sister	8.3	1.2	8.9	7.7	43.3	11.3	49.0	37.7	75.0

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

The level changes of vocabularies understanding scores for father, mother, older brother, and younger sister from condition-A to condition-A' increased by (61.1), (83.4), (61.1), (66.7) points. The PND on condition A/B for the vocabularies of the father, mother, and older brother was 100%, and the vocabulary of the younger sister was 80% (95% average). Furthermore, PND condition B/A' obtained 100% for the four vocabularies. So, the multilayer model effectively improves vocabulary understanding in LP-3. The score that assessed vocabulary knowledge in LP-4 is presented in Figure 8.

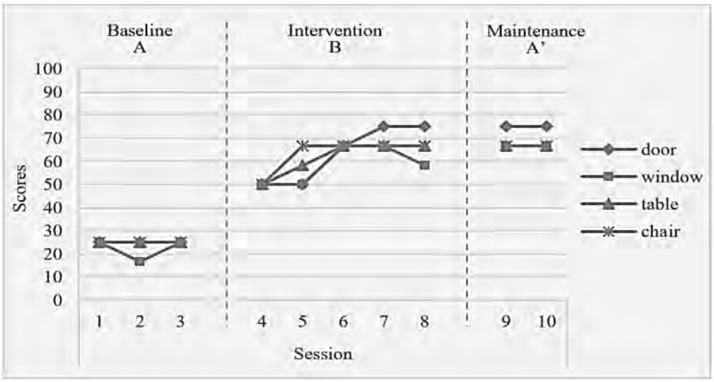

Figure 8. The score of vocabulary knowledge on each condition in LP-4

The direction trend shown in the four vocabularies in the baseline phase is almost the same: stable at low levels. The only fluctuating score was the second session baseline for the vocabulary of the window. In the first session of the intervention phase, all vocabularies immediately showed improved scores. For vocabulary of the door, improvement occurred again in the third and fourth sessions. The vocabulary of the window also had a score that increased in the third and fourth sessions but decreased in the fifth. Meanwhile, the vocabulary of table and chair increased in the second session of intervention and remained the same in the third to fifth sessions. Gradual changes that did not occur at every intervention session indicated that the multilayer model was latent (it took time) to change the ability to understand vocabulary. Furthermore, in the maintenance phase, the four vocabularies obtained a score that remained at the highest in the intervention phase. The statistical data achieved by Subject-1 in LP-4, including mean, stability range, and upper and lower limit, are presented in Table 5.

Table 5. Mean score, stability range, the upper and lower limit on LP-4

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Door	25.0	3.8	26.9	23.1	63.3	11.3	69.0	57.7	75.0
Window	22.2	3.8	24.1	20.3	58.3	10.0	63.3	53.3	66.7
Table	25.0	3.8	26.9	23.1	61.7	10.0	66.7	56.7	66.7
Chair	25.0	3.8	26.9	23.1	63.4	10.0	68.4	58.4	66.7

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

Change level in vocabulary understanding: door, window, table, and chair in condition-A and condition-A' if the difference in the mean score is calculated, there is an increase of (50.0), (44.5), (41.7), (41.7) points. The PND on condition A/B is 100% for the four vocabularies, which means that the impact of the intervention is very effective. Furthermore, PND for condition B/A' is 100% for the vocabulary: for door and window and 0% for the vocabulary for table and chair. The change in the PND from condition B/A' does not impact the conclusion when considering the data score remains high due to the intervention, which means the effect is permanent.

3.2. Subject-2

Graphically, the score achieved by subject-2, which assesses vocabulary knowledge in LP-1, is presented in Figure 9. In the baseline phase, three vocabularies (me, name, and female) have a fluctuating trend; rising from the first session to the second session, then settling on the third session. The vocabulary of males has a flat trend from the first to the third session and has the lowest value. Meanwhile, my vocabulary of me has a high-grade score level. Entering the first session of the intervention phase, there was an increase until the second session, which was settled in the third and fourth sessions. The latency element can be identified from the score increment stage, which takes two sessions to achieve the goal of the intervention to gain an understanding of each vocabulary. The trend illustrated in the intervention phase is an increase from the first to the second session, then flattens out in the third and fourth sessions. Only my vocab of me could reach the maximum score and remained until the fifth intervention session. Meanwhile, the vocabularies of name, male, and female decreased in the fifth intervention session. Furthermore, in the maintenance phase, the maximum score reached by my vocabulary of me at the time of intervention can be maintained. Meanwhile, the vocabularies of name, male, and female, which had experienced a decline in the score at the last session of the intervention, managed to get back up to the best score. The graph also shows the trend in the direction of the maintenance phase, flattening out at a high score for the vocabularies of me, name, and male. Meanwhile, the increasing trend is obtained for the vocabulary of females, although the score is lower than others. In terms of statistical data, recording scores, including averages, stability ranges, and upper and lower limits for LP-1, are presented in Table 6.

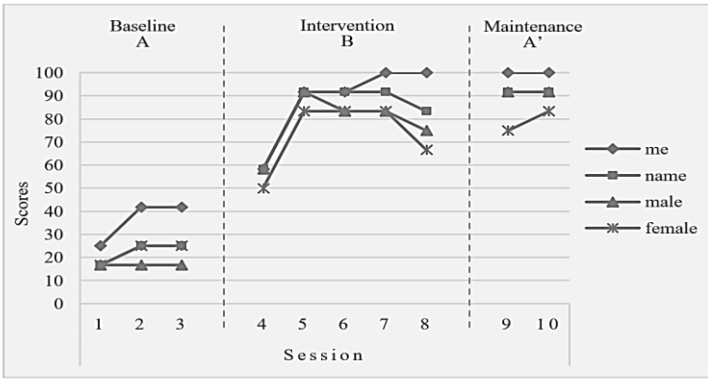

Figure 9. The score of vocabularies knowledge on each condition in LP-1

Table 6. Mean score, stability range, the upper and lower limit on LP-1

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Me	36.1	6.3	39.3	33.0	88.3	15.0	95.8	80.8	100.0
Name	22.2	3.8	24.1	20.3	83.3	13.8	90.2	76.4	91.7
Male	16.7	2.5	18.0	15.5	78.3	13.8	85.2	71.4	91.7
Female	22.2	3.8	24.1	20.3	73.3	12.5	79.6	67.1	79.2

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

The level change of scores for vocabularies (me, name, male, and female) in condition-A to condition-A' when calculated by the difference in mean scores, increases from (63.9), (69.5), (75.0), (56.9). The PND between A/B conditions for the four vocabularies is 100%. Meanwhile, PND between conditions B/A' is 100% for vocabularies me, name, and male, while the vocabulary of female got 50% (average 87.5%). The analysis between conditions B/A' aims to determine whether the treatment effect is permanent. These results indicate that the multilayer model effectively improves vocabulary understanding in LP-1. The score that assesses vocabulary knowledge in LP-2 is shown in Figure 10.

The graph of achievement LP-2 shows that in the baseline phase, the vocabulary of eyes and mouth has a fluctuating score, which has increased from the first session to the second session and is stable in the third session at different levels; the vocabulary of the eye has a higher level. In other words, the score of eye and mouth increased, then flattened out. The nose and ear vocabulary flatted from the first to the third session at a low level. In the intervention phase, it is clear that the four vocabularies immediately experience an increase in scores. The vocabulary of the eye has a better score than the other vocabularies. Although it has an immediate effect, the multilayer model also has latency because it takes time to achieve maximum performance from the second to the fourth session of intervention. From the graph, it can also be seen that for the entire vocabulary, there is a change in the level of score achievement from the baseline phase to the intervention phase and even to the maintenance phase. The calculated data for mean, stability range, and upper and lower limit in LP-2 are presented in Table 7.

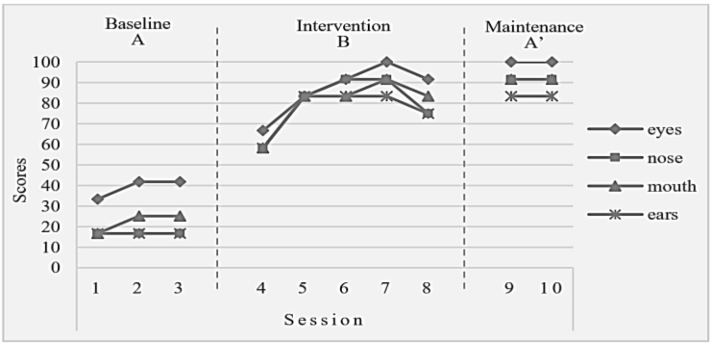

Figure 10. The score of vocabulary knowledge on each condition in LP-2

Table 7. Mean score, stability range, an upper and lower limit on LP-2

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Eye	38.9	6.3	42.1	35.8	86.7	15.0	94.2	79.2	100.0
Nose	16.7	2.5	18.0	15.5	80.0	13.8	86.9	73.1	91.7
Mouth	22.2	3.8	24.1	20.3	80.0	13.8	86.9	73.1	91.7
Ear	16.7	2.5	18.0	15.5	76.6	12.5	82.9	70.4	83.3

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

The level change of the vocabular understanding score of eyes, nose, mouth, and ears in condition-A to condition-A' when the difference in the average score is calculated, each vocabulary has an increase of (61.1), (75.0), (69.4), (66.6) points. Furthermore, the PND between A/B conditions and the four vocabularies have a percentage of 100% or no overlapping data. The data analysis explains that the greater the non-overlapping data rate obtained, the more effective the intervention will be. Meanwhile, PND between conditions B/A' also received a score of 100% for the four vocabularies, which indicates that in the maintenance phase, the achievement was still above the high-range intervention conditions. Subject-2 obtains a record of the assessment score in LP-3 depicted in Figure 11.

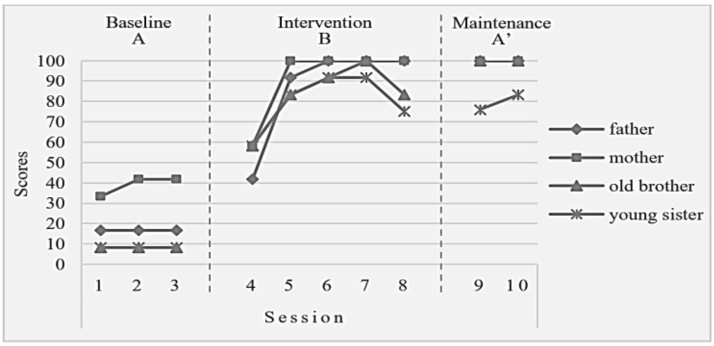

Figure 11. The score of vocabulary knowledge on each condition in LP-3

The trend shown by the graph above in the baseline phase is horizontal for the vocabulary of father, brother, and sister, where the father's vocabulary has a higher level. Meanwhile, the mother's vocabulary increased from the first session to the second session and flattened to the third session, with the highest scores. Before the intervention, subject-2 already had an understanding of 'mother' but still needs to be improved. Entering the first session intervention, immediately, the four vocabularies experienced an increase in score achievement. The most significant increase was in vocabulary: An older brother and younger sister, although it had not yet reached the highest score. This increased score continued to occur in the second and third intervention sessions, which indicates that the multilayer model has an element of latency, which takes time to achieve intervention goals. The increased score from one session to the next in the intervention phase also indicates a change in achievement. Furthermore, Table 8 presents the descriptive statistical data score, which includes the mean, stability range, and upper and lower limits achieved by subject-2 in LP-3.

Table 8. Mean score, stability range, the upper and lower limit on LP-3

Condition ⟶	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Father	16.7	2.5	18.0	15.5	86.7	15.0	94.2	79.2	100.0
Mother	38.9	6.3	42.1	35.8	91.7	15.0	99.2	84.2	100.0
Older-brother	8.3	1.2	8.9	7.7	83.3	15.0	90.8	75.8	100.0
Younger-sister	8.3	1.2	8.9	7.7	80.0	13.8	86.9	73.1	79.2

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

Changes in the level of vocabulary understanding for father, mother, older-brother, and younger-sister in the condition-A to condition-A' of each vocabulary has scores increased by (83.3), (61.1), (81,7), (70,9) points. The PND between the A/B conditions for the four vocabularies was 100%. Therefore, this multilayer model is very effective on the LP-3. Meanwhile, PND between conditions B/A' gets 100% for the vocabulary of father, mother, and older brother, and 0% for younger sister. As is known, in condition-A' the intervention process is no longer done. Calculating PND condition B/A' means finding out whether the effect of the intervention that is achieved is permanent or not. From graphic inspection, it is seen that each vocabulary in the maintenance phase has a high-level achievement. Figure 12 illustrates the score obtained by subject-2 on LP-4 taught using a multilayer model.

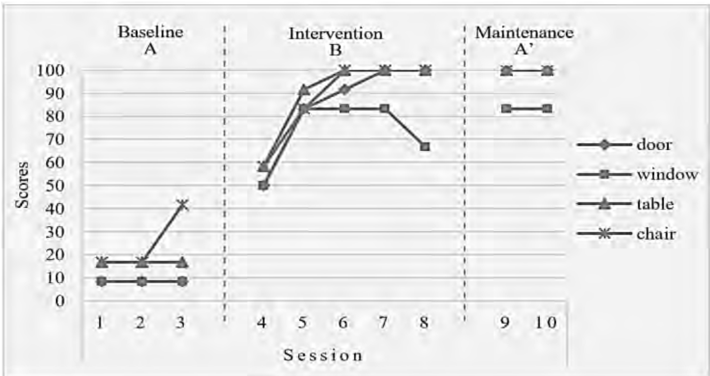

Figure 12. The score of vocabulary knowledge on each condition in LP-4

In the baseline phase, the trend scores indicated by the vocabularies of door and window flatten out at low levels, indicating the need for intervention. At a slightly higher-grade level, the vocabulary of the table tends to be in the same direction. Only the vocabulary of the chair had an increase in its score in the third session. Entering the intervention phase, the effect was immediately seen with the increased scores for the four vocabularies, continuing in the second and third sessions. Multilayer models need to be applied in several sessions to achieve maximum results. This suggests that the model has latency in attaining the goal of understanding vocabulary. The graph shows that the vocabulary of the window only increased until the second session of intervention, then stagnated in the third and fourth sessions, and even decreased in the fifth session. The graph also shows a big score achievement level from the baseline phase to the intervention phase, even in the maintenance phase, achieving maximum scores in the door, table, and chair vocabulary. Furthermore, the calculation of descriptive statistics, including the mean, stability range, and upper and lower limits obtained by subject-2 in LP-4, can be examined in Table 9.

Level change of vocabulary comprehension scores for door, window, table, and chair in condition-A to condition-A' has the average score (91.7), (75.0), (83.3), (75,0) point. Furthermore, PND on A/B conditions for the four vocabularies is 100%. PND between conditions B/A' also gets 100% for all four vocabularies. The PND B/A' indicates a high score level in the maintenance condition is still above the upper range of the intervention condition as a result of the intervention.

Table 9. Mean score, stability range, the upper and lower limit on LP-4

Condition →	(A)				(B)				(A')
Vocabularies	M	SR	UL	LL	M	SR	UL	LL	M
Door	8.3	1.2	8.9	7.7	85.0	15.0	92.5	77.5	100.0
Window	8.3	1.2	8.9	7.7	73.3	12.5	79.6	67.1	83.3
Table	16.7	2.5	18.0	15.5	90.0	15.0	97.5	82.5	100.0
Chair	25.0	6.3	28.2	21.9	88.3	15.0	95.8	80.8	100.0

Notes: M: Mean, UL: Upper limit=mean+(½SR),
SR: Stability range=highest score×15% [45], LL: Lower limit=mean-(½SR)

4. DISCUSSION

Subjects 1 and 2 have formal education recognized at the ages of 11 and 8, which means that children with special needs do not receive adequate education from an early age. Since they are severely deaf, they need an alternative to early reading instruction from an early age [53]. Deaf people have significant difficulty understanding written texts because their hearing loss has prevented them from being exposed to the spoken language since they were babies [32]. Before school, both subjects lived with parents who had difficulty communicating. This situation affects the lack of vocabulary they have. However, signs, symbols, and images can enable the deaf to read, although reading picture books does not equate to the complex skills of fluent readers [53]. Using pictures to read has become a widely recommended strategy rather than focusing only on language and spoken words [54]. Images as a visualization strategy optimize the mind’s capacity to imagine something conveyed by sound, gesture, and spatial layout in the text [55]. However, including digital elements in the form of video recordings for total communication, which can be accessed through a screen or tablet, stimulates participants’ interest in learning [18], [20]. Therefore, a diverse and comprehensive learning model such as a multilayer model is needed to help reading comprehension because it has many elements to overcome the weaknesses experienced by children with hearing impairment.

Concrete objects and images are the first layers, followed by the second layer (sign language), which is the main communication asset for the deaf. However, sign language needs to be strengthened with writing (third layer) and pronunciation (fourth layer) [25]. Researchers perceive the importance of symbols, pictures, and concrete objects to support further understanding of the reading. It was recorded that in the intervention process, the two subjects experienced doubts about doing the sign language layer for the word ‘mouth,’ ‘male,’ and ‘father’ (in the context of the Indonesian sign language system). This result is because all three words have the same qualifying area around the mouth. The use of ‘total communication’ videotapes is beneficial for both subjects, as they can play back at any time.

With the multilayer model, this weakness is overcome by another layer. The picture cards of male and female symbols and sign language help them understand the vocabulary, even though they are a bit abstract. The fourth layer (pronunciation) only makes meaningful progress in some LP. Of course, this result is related to deafness experienced by subjects since birth, making it challenging to teach speaking, which encourages visual communication [56]. Meanwhile, the fifth layer (total communication), which combines the sign language layer and the pronunciation layer, is dominated by sign language, more so with the help of video recordings. Researchers included pronunciation as one of the layers because of the social element, where the deaf do not constantly interact with people who understand sign language. There is a significant positive relationship between family communication patterns and family resilience[57], with preference to conversation orientations but also the habits and abilities of the interlocutor [28]. The results of the intervention, which did not record exemplary achievements on the pronunciation layer, reminded researchers of the importance of a support system for the education of children with special needs, in this case, speech therapy and the use of medical technology as early as possible [58].

The sixth layer, in the form of a matching picture, word, and character cards, can be completed well by the two subjects, even if they can combine two word or character cards into short sentences with meaning. Subject-1 can form the sentence "me male" and "my mother" using picture cards. Subject-2 can make up the sentence "name me," my younger sister," or "mother chair" using a signed card paired with a picture card. Deaf readers who understand the meaning of written language can sometimes gain understanding directly from written symbols or, in other situations, through signing [25].

5. CONCLUSION

Subject-1 has an average PND between B/A conditions: LP-1 with vocabulary teaching material: me, name, male, female, by 90%, LP-2 teaches vocabulary eye, nose, mouth, ear by 100%, LR-3 with teaching materials: father, mother, older brother, and younger sister, by 95%, and LP-4 with teaching materials: door, window, table, and chair, by 100%. The PND between conditions A'/B is: LP-1 is 100%, LP-2 is 100%, LP-3 is 100%, and LP-4 is 75%. Subject-2, with the same LP load, had an average PND between B/A conditions: LP-1 to LP-4 was 100%. PND between conditions A'/B is: LP-1 is 87.5%, LP-2 is 100%, LP-3 is 75%, LP-4 is 100%.

The average PND achievement between B/A conditions for the four LP on subject-1 was 96.25%, and subject-2 was 100%. It can be concluded that the multilayer model effectively improves vocabulary reading comprehension for both subjects. While the average PND achievement between conditions A'/B on subject-1 was 93.75% and subject-2 was 89.87%. This percentage indicates that the subject's vocabulary knowledge is maintained without further intervention.

ACKNOWLEDGEMENTS

We would like to thank the principals and teachers from the Special School of Bhakti Luhur and Special School of YPAC Malang City who allowed and supported us in conducting research on their students.

REFERENCES

[1] T. Haug and S. Ebling, "Using Open-Source Software for Sign Language Learning and Assessment," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 14, no. 19, p. 188, 2019, doi: 10.3991/ijet.v14i19.11123.

[2] F. M. Alqraini, "Identifying similarities and differences on how deaf and hard of hearing students learn new vocabulary knowledge," *International Journal of Instruction*, vol. 11, no. 4, pp. 61–74, 2018, doi: 10.12973/iji.2018.1145a.

[3] J. B. Tomblin, J. Oleson, S. E. Ambrose, E. A. Walker, R. W. Mccreery, and M. P. Moeller, "Aided hearing moderates the academic outcomes of children with mild to severe hearing loss," *Ear & Hearing*, vol. 41, no. 4, pp. 775–789, 2020, doi: 10.1097/AUD.0000000000000823.

[4] M. Abou-Abdallah and A. Lamyman, "Exploring communication difficulties with deaf patients," *Clinical Medical Journal*, vol. 21, no. 4, pp. 380–383, 2021, doi: 10.7861/CLINMED.2021-0111.

[5] S. D. Antia *et al.*, "Language and reading progress of young deaf and hard-of-hearing children," *Journal of Deaf Studies and Deaf Education*, vol. 25, no. 3, pp. 334–350, 2020, doi: 10.1093/deafed/enz050.

[6] M. Salehomoum, "Scaffolding development of self-regulated and strategic literacy skills in deaf or hard-of-hearing students: a review of the literature through the Lens of the gradual release of responsibility model," *Literacy Research, Practice and Evaluation*, vol. 10, pp. 153–168, 2019, doi: 10.1108/S2048-045820190000010010.

[7] Y. Subasno, N. S. Degeng, M. Pali, and I. Hitipeuw, "The effectiveness of multiplex teaching method in mastering vocabulary for deaf students," *European Journal of Educational Research*, vol. 10, no. 4, pp. 1649–1667, 2021, doi: 10.12973/eu-jer.10.4.1649.

[8] Y. A. Widia, "Vocabulary Acquisition of Deaf Children Based on Indonesian Word Classes at SDLB Karya Mulia II Surabaya (in Indonesian)," *Skriptorium, Journal Universitas Airlangga*, vol. 1, no. 1, pp. 128–140, 2013.

[9] K. M. Benedict, M. C. Rivera, and S. D. Antia, "Instruction in metacognitive strategies to increase deaf and hard-of-hearing students' reading comprehension," *Journal of Deaf Studies and Deaf Education*, vol. 20, no. 1, pp. 1–15, 2015, doi: 10.1093/deafed/enu026.

[10] L. Bickham, "Reading comprehension in deaf education: Comprehension strategies to support students who are deaf or hard of hearing," St. John Fisher College, 2015.

[11] Y. Zhao, X. Wu, P. Sun, and H. Chen, "Relationship between vocabulary knowledge and reading comprehension in deaf and hard of hearing students," vol. 26, no. 4, pp. 546–555, 2021, doi: 10.1093/deafed/enab023.

[12] N. Friedmann and R. Szterman, "The comprehension and production of wh-questions in deaf and hard-of-hearing children," *Journal of Deaf Studies and Deaf Education*, vol. 16, no. 2, pp. 212–235, 2011, doi: 10.1093/deafed/enq052.

[13] R. I. Mayberry and Q. Cheng, "When event knowledge overrides word order in sentence comprehension: Learning a first language after childhood," *Developmental Science*, vol. 24, no. 5, p. e13073, 2020, doi: 10.1111/desc.13073.

[14] A. Delcenserie, F. Genesee, N. Trudeau, and F. Champoux, "A multi-group approach to examining language development in at-risk learners," *Journal of Child Language*, vol. 46, pp. 51–79, 2019, doi: 10.1017/S030500091800034X.

[15] P. H. Janssen, *Education for deaf children (in Indonesian)*. Malang: Bhakti Luhur Foundation/ Yayasan Bhakti Luhur, 2007.

[16] M. M. and P. C. Hauser, *How Deaf Children Learn*. Oxford: Oxford University Press, 2011.

[17] Munir, W. Setiawan, E. P. Nugroho, J. Kusnendar, and A. P. Wibawa, "The effectiveness of Multimedia in Education for Special Education (MESE) to improve reading ability and memorizing for children with intellectual disability," *International Journal of Emerging Technologies in Learning*, vol. 13, no. 8, pp. 254–263, 2018, doi: 10.3991/ijet.v13i08.8291.

[18] B. Baglama, M. Haksiz, and H. Uzunboylu, "Technologies used in education of hearing impaired individuals," *International Journal of Emerging Technologies in Learning (iJET)*, vol. 13, no. 9, pp. 53–63, Sep. 2018, doi: 10.3991/ijet.v13i09.8303.

[19] V. Kourbetis, S. Karipi, and K. Boukouras, "Digital Accessibility in the Education of the Deaf in Greece," *In: Antona M., Stephanidis C. (eds) Universal Access in Human-Computer Interaction. Applications and Practice. HCII 2020. Lecture Notes in Computer Science, vol 12189. Springer, Cham*, 2020, doi: 10.1007/978-3-030-49108-6_8.

[20] R. A. M. Kurnia, D. L. Hakim, and A. Ana, "The development of digital video applications for deaf students," *Journal of Physics: Conference Series*, vol. 1318, no. 1, 2019, doi: 10.1088/1742-6596/1318/1/012149.

[21] A. S. Pratiwi *et al.*, "Digital Video Based Rampak Kendang Learning Media for Deaf Students," *Journal of Physics: Conference Series*, vol. 1179, no. 1, pp. 6–11, 2019, doi: 10.1088/1742-6596/1179/1/012040.

[22] E. R. Amalia and S. Khoiriyati, "Effective learning activities to improve early childhood cognitive development," *Al-Athfal Child Education Journal/ Al-Athfal Jurnal Pendidikan Anak*, vol. 4, no. 1, pp. 103–111, 2018, doi: 10.14421/al-athfal.2018.41-07.

[23] L. K. Vida, "Piaget's genetic approach to reading and language development," in *Annual Meeting of the Southeastern Regional Conference of the International Reading Association*, 1980, p. 16.

[24] A. Shafi, J. Tahir, H. Waqar, U. Hamid, and R. A. Pampori, "Prelingual feafness : an overview of treatment outcome," *Indian Journal of Otolaryngology and Head & Neck Surgery*, vol. 71, no. 2, pp. 1078–1089, 2019, doi: 10.1007/s12070-017-1181-7.

[25] C. J. Enns, *A language and literacy framework for bilingual deaf education*. Winnipeg: Faculty of Education, University of

Manitoba, 2006.
[26] P. Aleksandrowicz, "The reading comprehension skill of d/deaf and hard-of-hearing poles and its importance for media accessibility: a pilot study," *Journal of Audiovisual Translation*, vol. 2, no. 1, pp. 26–52, Nov. 2019, doi: 10.47476/jat.v2i1.87.
[27] J. L. Falk, K. A. Di Perri, A. Howerton-Fox, and C. Jezik, "Implications of a sight word intervention for deaf students," *American Annals of the Deaf*, vol. 164, no. 5, pp. 592–607, 2020, doi: 10.1353/aad.2020.0005.
[28] Muljono, G. W. Saraswati, N. A. S. Winarsih, N. Rokhman, C. Supriyanto, and Pujiono, "Developing BacaBicara: An Indonesian lipreading system as an independent communication learning for the deaf and hard-of-hearing," *International Journal of Emerging Technologies in Learning*, vol. 14, no. 4, pp. 44–57, 2019, doi: 10.3991/ijet.v14i04.9578.
[29] M. Marschark, C. Morrison, J. Lukomski, G. Borgna, and C. Convertino, "Are deaf students visual learners?," *Learning and Individual Differences*, vol. 25, pp. 156–162, 2013, doi: 10.1016/j.lindif.2013.02.006.
[30] D. Walton, G. Borgna, M. Marschark, K. Crowe, and J. Trussell, "I am not unskilled and unaware: deaf and hearing learners' self-assessments of linguistic and nonlinguistic skills," *European Journal of Special Needs Education*, vol. 34, no. 1, pp. 20–34, Jan. 2019, doi: 10.1080/08856257.2018.1435010.
[31] J. F. Andrews and J. M. Mason, "How do deaf children learn about prereading ?," *American Annals of the Deaf*, vol. 131, no. 3, pp. 210–217, 1986, doi: 10.1353/aad.2012.0802.
[32] M. Berke, "Reading books with young deaf children: Strategies for mediating between American Sign Language and English," *Journal of Deaf Studies and Deaf Education*, vol. 18, no. 3, pp. 299–311, 2013, doi: 10.1093/deafed/ent001.
[33] F. M. Alqraini and P. V Paul, "The effects of a vocabulary intervention on teaching multiple-meaning words to students who are deaf and hard of hearing," *Journal of Deaf Studies and Deaf Education*, vol. 25, no. 4, pp. 469–489, 2020, doi: 10.1093/deafed/enaa015.
[34] S. Komaladani, A. Hufad, E. Rochyadi, Shyhabuddin, and A. B. D. Nandiyanto, "Teaching Tyndall Effects in Colloidal System to Deaf and Hard Hearing Students," *Journal of Enginering Sicence and Technology, Special Issue on AASEC2019*, pp. 58–67, 2020.
[35] B. K. Strassman, K. Marashian, and Z. Memon, "Teaching academic language to d/deaf students: Does research offer evidence for practice ?," *American Annals of the Deaf*, vol. 163, no. 5, pp. 501–533, 2019, doi: 10.1353/aad.2019.0001.
[36] L. N. Wauters, W. H. Van Bon, and A. E. Tellings, "Reading comprehension of Dutch deaf children," *Reading and Writing*, vol. 19, pp. 49–76, 2006, doi: 10.1007/s11145-004-5894-0.
[37] M. Rezaei, V. Rashedi, and E. K. Morasae, "Reading skills in Persian deaf children with cochlear implants and hearing aids," *International Journal of Pediatric Otorhinolaryngology*, vol. 89, pp. 1–5, 2016, doi: 10.1016/j.ijporl.2016.07.010.
[38] N. Takahashi, Y. Isaka, T. Yamamoto, and T. Nakamura, "Vocabulary and grammar differences between deaf and hearing students," *Journal of Deaf Studies and Deaf Education*, pp. 1–17, 2016, doi: 10.1093/deafed/enw055.
[39] F. E. Kyle and M. Harris, "Concurrent correlates and predictors of reading and spelling achievement in deaf and hearing school children," *Journal of Deaf Studies and Deaf Education*, vol. 11, no. 3, pp. 273–288, 2006, doi: 10.1093/deafed/enj037.
[40] A. van Staden, "An evaluation of an intervention using sign language and multi-sensory coding to support word learning and reading comprehension of deaf signing children," *Child Language Teaching and Therapy*, vol. 29, no. 3, pp. 305–318, 2016, doi: 10.1177/0265659013479961.
[41] K. Q. Hussein and M. A. Al-bayati, "Multi-mode e-learning system of reading skills for deaf students based on visual multimedia," *International Journal of Interactive Mobile Technologies*, vol. 16, no. 10, pp. 67–78, 2022, doi: 10.3991/ijim.v16i10.29831.
[42] J. W. Creswell, *Educational research: Planning, conducting, and evaluating quantitative and qualitative research*, 4th ed. New York: Pearson, 2012.
[43] R. H. Horner, E. G. Carr, G. Mcgee, S. Odom, and M. Wolery, "The use of Single-Subject Research to identify evidence-based practice in special education," *Exceptional Children*, vol. 71, no. 2, pp. 165–179, 2005, doi: 10.1177/001440290507100203.
[44] R. S. Jhangiani, I.-C. A. Chiang, C. Cuttler, and D. C. Leighton, *Research methods in psychology*, 4th ed. Creative Commons Attribution-NonCommercial-ShareAlike 4.0 International License, 2019.
[45] J. Sunanto, K. Takeuchi, and H. Nakata, *Introduction to Single Subject Research (in Indonesian)*. Tsukuba: Center for Research on International Cooperation in Educational Development (CRICED), 2005.
[46] H. D. Barlow and M. Hersen, *Single case experimental designs: strategies for studying behavior change*, 3rd ed. New York: Pergamon Press, 1984.
[47] B. R. Hergenhahn and M. H. Olson, *Theories of Learning*, 7th ed. Jakarta: Kencana Prenada Media Group, 2008.
[48] L. L. Cohen, A. Feinstein, A. Masuda, and K. E. Vowles, "Single-Case Research Design in Pediatric Psychology : Considerations Regarding Data Analysis," vol. 39, no. 2, pp. 124–137, 2014, doi: doi:10.1093/jpepsy/jst065.
[49] Y. Subasno, K. Nini, and C. Densi, "Improving vocabulary reading skills with word card and picture card for moderate intellectual disabilities," *Journal of ICSAR*, vol. 6, no. 1, pp. 101–110, 2022, doi: 10.17977/um005v6i12022p101.
[50] T. E. Scruggs and M. A. Mastropieri, "How to summarize single participant research: Ideas and applications," *Exceptionality: A Special Education Journal*, vol. 9, no. 4, pp. 227–244, 2015, doi: 10.1207/S15327035EX0904_5.
[51] R. Manolov, J. L. Losada, S. Chacón-Moscoso, and S. Sanduvete-Chaves, "Analyzing two-phase single-case data with non-overlap and mean difference indices: Illustration, software tools, and alternatives," *Frontiers in Psychology*, vol. 7, no. 32, pp. 1–16, 2016, doi: 10.3389/fpsyg.2016.00032.
[52] M. L. Olive and J. H. Franco, "(Effect) size matters: And so does the calculation," *The Behavior Analyst Today*, vol. 9, no. 1, pp. 5–10, 2008, doi: 10.1037/h0100642.
[53] J. F. Andrews, B. Hamilton, K. M. Dunn, and M. D. Clark, "Early reading for young deaf and hard of hearing children: Alternative frameworks," *Psychology*, vol. 7, pp. 510–522, 2016, doi: 10.4236/psych.2016.74052.
[54] J. L. Mounty, C. T. Pucci, and K. C. Harmon, "How deaf American sign language/English bilingual children become proficient readers: An emic perspective," *Journal of Deaf Studies and Deaf Education*, vol. 19, no. 3, pp. 333–346, 2014, doi: 10.1093/deafed/ent050.
[55] K. A. Mills, "Floating on a Sea of Talk: Reading Comprehension Through Speaking and Listening," *The Reading Teacher*, vol. 63(4), pp. 325–329, 2009, doi: 10.1598/RT.63.4.8.
[56] N. Parveen, A. Roy, D. S. Sandesh, J. Y. P. R. S. Srinivasulu, and N. Srikanth, "Human Computer Interaction Through Hand Gesture Recognition Technology," *International Journal of Scientific & Technology Research*, vol. 9, no. 4, pp. 505–513, 2020.
[57] M. R. Ramadhana, R. Karsidi, P. Utari, and D. T. Kartono, "The Role of Family Communication in the Family Resilience of Deaf Children's Families," *Journal of Family Issues*, vol. 43, no. 11, pp. 2972–2985, 2021, doi: 10.1177/0192513X211038074.
[58] A. Ioannou and V. Constantinou, "Augmented reality supporting deaf students in mainstream schools: Two case studies of practical utility of the technology," *Springer International Publishing AG, part of Springer Nature*, pp. 387–396, 2018, doi:

10.1007/978-3-319-75175-7_39.

BIOGRAPHIES OF AUTHORS

Yohanes Subasno is a lecturer in the Pastoral Ministry Study Program, STP-IPI Malang with main teaching courses: Educational psychology, general psychology, psychology of children with special needs, developmental psychology, and also education science. In the field of research, he has conducted several studies related to the empowerment of children with special needs, especially for the field of education. He served as a head of study program in the period 2012-2016, vice chairman-I for academic affairs in 2016-2019, and served as chairman at the STP- IPI Malang in 2019-2023. He has also experience as training manager for caregivers and fieldworkers of CBR at Bhakti Luhur Foundation in 2010-2017. Active as a board member of the Indonesian CBR Alliance and worked in the humanitarian field in Malang City through the 'Disability Social Rehabilitation Post' in the Malang City Social Service from 2015 until now. He can be contacted at email: subasno@gmail.com or subasno@stp-ipi.ac.id.

Imanuel Hitipeuw is a lecturer at the Doctoral Educational Psychology Study Program, Faculty of Psychology, State University of Malang who has expertise in the field of education for children with special needs and assessment. Until the time this biography is written, he occupied the position of coordinator of the study program. In the last three years, the courses he teaches include: Educational psychology, behavior modification, psychopedagogics, and perpectives in education, as well as a lot of guiding the dissertation writing for doctoral students in the study program he serves. His scientific work is widely published in various national and international journals, including: The influence of video based on experiential learning toward the socio-emotion of the children in kindergarten, learning and learning, punishment and reinforcement: survey of understanding of special schools teachers. He can be contacted at email: imanuel.hitipeuw.fip@um.ac.id.