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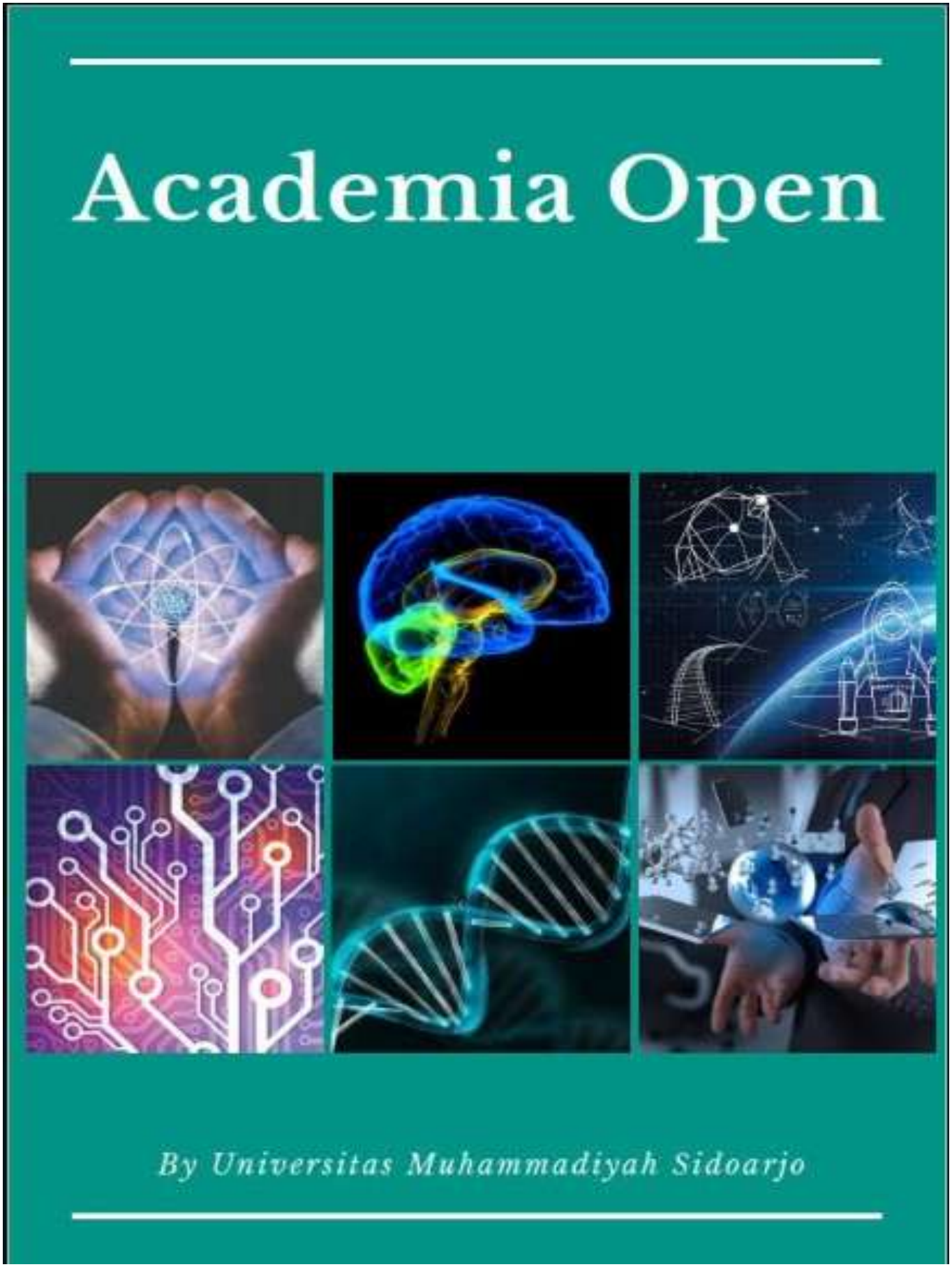

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Table Of Contents

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Academia Open

Vol. 11 No. 2 (2026): December
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Supporting Deaf Student Communication Using Low Tech Augmentative And Alternative Communication: Mendukung Komunikasi Siswa Rungu Menggunakan Komunikasi Augmentatif Dan Alternatif Berteknologi Rendah

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Abstract

General Background Communication competence represents a fundamental requirement for academic inclusion, but learners with hearing impairments frequently experience severe language deprivation without specialized support. **Specific Background** Inclusive elementary schools in resource-constrained, disadvantaged, frontier, and outermost regions often lack the digital infrastructure required for high-technology interventions. **Knowledge Gap** While previous studies highlight computerized solutions for autism in urban settings, evidence remains scarce regarding the application of non-digital visual tools for hearing-impaired learners within rural inclusive classrooms. **Aims** This Classroom Action Research investigates the application of non-digital visual supports to facilitate the receptive and expressive language abilities of a fourth-grade hearing-impaired learner. **Results** Following two intervention cycles utilizing color-coded visual boards and adaptive picture stories, receptive language understanding increased from 20.0 percent to 75.0 percent, while expressive language production ultimately reached 66.7 percent. Furthermore, classroom learning participation surged from 15.0 percent to 81.3 percent, alongside an 80.0 percent post-test achievement. **Novelty** This study provides a contextualized instructional framework that transitions hearing-impaired individuals from unstructured home signs to functional symbolic exchanges using exclusively affordable, non-digital visual materials. **Implications** Teachers and inclusive schools in resource-limited areas must adopt non-digital visual supports alongside systematic prompt fading and peer-mediated activities to ensure sustainable educational participation.

Highlights

- Color coded visual boards and adaptive picture stories substantially raise classroom participation rates.
- Receptive and expressive language abilities progress significantly through systematic prompt fading and peer interaction.
- Non digital visual interventions provide sustainable instructional solutions for marginalized and resource limited educational regions.

Keywords

Hearing Impairment; Receptive Language; Expressive Language; Inclusive Classrooms; Resource Limited Regions

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INTRODUCTION

Communication is basically the key to success in learning at school. Good communication helps students understand instructional material, follow directions from their teachers, participate in activities in the classroom, and develop meaningful social relationships with their classmates. Communication competence has two related dimensions: receptive communication, the ability to understand and interpret messages from the environment and expressive communication, the ability to express thoughts, needs, and ideas to others (Beukelman & Light, 2020; Wolbers et al., 2023). These skills are usually acquired naturally through everyday interactions, however, children with hearing impairment face significant barriers and require specialized educational support. Children with hearing loss don't have access to spoken language, which is the primary form of communication in most schools. Consequently, many students with a hearing impairment have delayed vocabulary development, limited grammatical development, difficulties in interpreting contextual meaning, and challenges in developing literacy skills, especially reading and writing (Hall et al., 2017; Porcar-Gozalbo et al., 2024; WHO, 2021). These language limitations affect academic achievement but also decrease classroom participation, social interaction and independent learning.

Globally, there are approximately 34 million children living with disabling hearing loss, which can have a profound effect on language development and educational engagement without early communication intervention (WHO, 2021). In the 2023/2024 academic year, there were 158,792 students enrolled in special education schools in Indonesia (Frisca Rizti, 2024). Nevertheless, the level of children with disabilities' participation in education remains relatively low, especially in rural and underprivileged areas. Disadvantaged, frontier, and outermost (3T) regions experience the gaps even more severely, with schools often lacking qualified teachers, sufficient instructional materials, and access to assistive technologies (Kemendikdasmen, 2025; Rohmani et al., 2025; UNESCO, 2008). These conditions point to the importance of communication interventions that are feasible, affordable and sustainable in resource-constrained settings. Augmentative and Alternative Communication (AAC) is a well known evidence based intervention to supplement or replace spoken communication for individuals with complex communication needs (Ganz et al., 2021; Leonet et al., 2022; Morin et al., 2018). Recent AAC advances have been more about high-tech digital technologies like speech-generating devices, tablets and mobile applications. These high-tech systems are quite effective, but their implementation needs electricity, internet access, technical maintenance and significant financial investment, which makes them difficult to be adopted in many inclusive schools located in remote regions (Comino et al., 2025; Riswari et al., 2022). Low-tech AAC, such as picture cards, communication boards, visual schedules and printed communication books, offers an accessible alternative as it is inexpensive, easy to produce locally, not reliant on digital infrastructure and compatible with the visual learning characteristics of students with hearing impairments.

The Minister of National Education Regulation No. 70 of 2009 has created a strong legal basis for inclusive education in Indonesia which guarantees the right of students with disabilities to obtain education in regular schools. In addition, the Merdeka Curriculum encourages teaching practices that address learner diversity and individual educational needs (Kemendikbudristek, 2022). However, major gaps still exist between policy and classroom application, particularly in the 3T areas. Teachers often work with students with disabilities with inadequate professional preparation, little instructional media and limited access to specialized educational support . Communication barriers, therefore, often remain unaddressed and students are unable to participate fully in classroom learning.

This condition was found in SDN 007 Batu Ampar, an inclusive elementary school in the 3T area of East Kutai Regency, East Kalimantan. There are 17 students in Grade IV, one student with hearing impairment (M.A.) who had a significant receptive and expressive communication difficulty. Initial classroom observations indicated that M.A. responded correctly to about 20% of the teachers' verbal instructions when visual cues were not used, recognized about 19% of the alphabet letters, was actively involved in classroom learning for about 15% of the instructional time, and that over 60% of the messages the student attempted to communicate were misinterpreted by teachers and classmates. Naturalistic observations over three weeks showed that M.A. used home signs, pointing gestures, and physical prompts much more than conventional language. The student often did not understand multistep instructions during Indonesian language lessons, and often waited for classmates to respond before attempting to complete tasks independently. These results suggest that communication barriers were a significant impediment to academic participation and classroom autonomy. Crucially, these communication problems are not merely the result of hearing impairment. Rather, they represent the combined effects of limited early language exposure, socioeconomic constraints, and prolonged exposure to teaching methods that relied almost entirely on verbal communication, lacking sufficient visual aids. Hall et al., (2017) describe language deprivation syndrome, stating that most language delays in children with hearing impairments are due to poor access to effective communication systems and not hearing loss. Hence, the provision of accessible communication support in the context of everyday classroom instruction is critical to facilitate language development and academic inclusion.

Despite a growing body of literature demonstrating the efficacy of AAC, several important research gaps remain. Prior research focused mainly on children with autism spectrum disorder, was carried out mostly in urban educational settings, and placed greater emphasis on functional daily communication than on curriculum-based academic instruction (Rezkiani & Aprilia, 2023). In addition, there are very few research studies on the use of low-tech AAC to students with hearing impairment in inclusive classrooms, particularly in resource-limited schools in 3T regions of Indonesia. Therefore, there is scant evidence for the use of real-world, low-cost AAC interventions that can be provided by general education teachers. To fill these gaps, the present study investigates the implementation of low-tech Augmentative and Alternative Communication (AAC) integrated into Indonesian language instruction to improve the receptive and expressive communication skills of a fourth-grade student with hearing impairment at SDN 007 Batu Ampar. This Classroom Action Research (CAR) design research aims to improve classroom practice and to offer an inexpensive, contextually relevant and replicable instructional

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model that can be used to support inclusive education in schools with similar resource constraints across Indonesia.

METHOD

The design of this study is Classroom Action Research (CAR) which applies the spiral model of Kemmis and McTaggart consisting of four stages that are performed iteratively, namely: planning, action, observation, and reflection. CAR was selected as the focus of the study because the main aim of the study was to improve classroom practice by addressing real communication barriers experienced by a student with hearing impairment in an inclusive educational setting. The study employed both qualitative and quantitative descriptive approaches to give a thorough analysis of the implementation process of the intervention and the changes in the student's communication performance. The research was conducted from March to June 2026 at SDN 007 Batu Ampar, an inclusive elementary school located in a disadvantaged, frontier, and outermost (3T) area, East Kutai Regency, East Kalimantan. The participant was a fourth-grade student with a hearing impairment identified by the initials M.A. who had severe receptive and expressive communication difficulties and had never received structured AAC intervention. The intervention took place in the usual inclusive classroom, offering communication support in a real-world learning environment rather than in a controlled experimental setting.

The intervention comprised two cycles of action, each with four meetings (three instructional sessions, and one post-test). Cycle I instruction involved the introduction of single AAC symbols with low-tech communication materials (e.g., picture cards, visual communication boards, contextual graphic symbols) and aided language input through teacher modeling. The reflection results of Cycle I served as the basis for Cycle II, which focused on the integration of multiple symbols, systematic prompt fading, adaptive picture stories, increased independence in communication, and structured peer-to-peer communication activities. In Cycle 1 and Cycle 2, Indonesian language learning was implemented by integrating low-tech AAC into the learning process without the use of electricity, internet, and digital devices. Data were gathered using three methods: structured classroom observations, AAC-based communication tests and documentation. Receptive communication, expressive communication and learning participation were assessed using observation instruments with a four-point rating scale. Pre-tests and post-tests consisted of ten nonverbal AAC-based tasks to evaluate communication performance before and after each intervention cycle. Documentation to support the study included field notes, photographs, student work and instructional materials used throughout the study. All instruments were assessed by expert judgment for content validity. Inter-rater reliability was tested by independent observation by a collaborating teacher using the Percentage Agreement method with the minimum acceptable agreement of 80%.

Descriptive statistics included mean scores and percentages of receptive communication, expressive communication, learning participation, and communication test performance in the pre-action stage, Cycle I, and Cycle II for quantitative data. Qualitative data were collected from observations and field notes and were analyzed using data reduction, data display, and conclusion drawing to explain the changes that occur during the intervention. The study was successful if the student achieved an average observation score of ≥2.5 on a four-point scale and a post-test score of ≥70%, indicating functional improvement in receptive communication, expressive communication, and active participation in classroom learning.

RESULT AND DISCUSSION

Baseline Condition (Pre-Intervention)

Baseline data were collected over three weeks of naturalistic classroom observations (March 2026) and an AAC-based communication pre-test prior to intervention implementation. This phase was conducted to obtain a reliable baseline of the student's receptive communication, expressive communication, and classroom participation to inform the development of an intervention that was contextually appropriate. During the baseline period, classroom instruction was consistent with the normal teaching practices of the school and was primarily verbal in nature and did not involve the use of Augmentative and Alternative Communication (AAC). Thus, the data represented the participant's actual communicative performance before intervention. Baseline observations indicated substantial communication problems. The student's (M.A.) receptive language skills were limited as evidenced by his responding correctly to only 20% of the teacher's verbal directions (without visual cues or gestures) in the classroom. Concerning expressive communication, the teacher or the classmates understood less than 40% of the messages that the student wanted to express. Communication was mostly based on home signs, nonstandard gestures and unstructured vocalizations often not communicating the intended meaning. Classroom participation was also very limited. The student was actively engaged in learning activities during only approximately 15% of instructional time, with the vast majority of classroom sessions spent passively observing peers.

The results suggest that the communication barriers were not simply the result of hearing impairment per se. The classroom records indicate that the student had not received structured communication support or instruction in the use of AAC over four years of elementary education. The classroom learning was almost entirely by oral teaching, with no systematic visual support. This prolonged period of inadequate language input is in line with the notion of language deprivation syndrome, which suggests that language delays in children with hearing impairments are mainly due to limited access to effective communication systems, rather than to hearing loss alone (Hall et al., 2021). Summary of baseline communication performance before intervention is presented in Table 1.

Table 1. *Baseline Communication Performance of Student M.A.*

No.	Measured Aspect	Score (1–4 Scale)	Percentage	Description
1	Receptive communication	0.80	20.0%	Very poor; rarely responded appropriately to verbal instructions
2	Expressive communication	1.60	40.0%	Very limited; messages were generally not understood

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				without repeated clarification
3	Learning participation	0.50	12.5%	Extremely low; remained passive throughout most classroom activities
4	Early literacy (alphabet recognition)	–	19.0%	Recognized mainly vowel letters; remained at the emergent pre-reading stage

In summary, the baseline findings show a large gap between the student's current communication skills and the expected competencies for students in the fourth grade. The receptive communication score (0.80/4) and expressive communication score (1.60/4) were significantly below the standard necessary for meaningful engagement in classroom learning. Likewise, the very low rate of participation suggested that traditional teacher-centred verbal instruction was not effective in supporting the student's inclusion in the classroom. Based on these baseline findings, low-tech Augmentative and Alternative Communication (AAC) was selected as the intervention for three primary reasons. First, the student's visual learning modality conflicted with the mostly oral instructional approach that had been used previously; students with hearing impairments depend mainly on visual input to acquire and process information (Swanwick & Salter, 2024). Second, low-tech AAC, such as picture cards, communication boards, and printed graphic symbols, is inexpensive, easy to produce, and does not require electricity or internet access. This makes it especially suitable for schools in disadvantaged, frontier, and outermost (3T) regions (Comino et al., 2025). Third, previous studies have always demonstrated the effectiveness of AAC in enhancing both receptive and expressive communication skills among students with complex communication needs (Ganz et al., 2021; Leonet et al., 2022; Riswari et al., 2022). The present study was based on these considerations and implemented a structured low-tech AAC intervention.

Cycle I

Cycle I was designed on the basis of the findings obtained in the baseline assessment. The intervention focused on the introduction of low-tech Augmentative and Alternative Communication (AAC) to support receptive and expressive communication in Indonesian language instruction. The learning materials Garuk-Garuk, the importance of drinking water, and identifying key information from simple health-related texts were utilized to develop an individualized lesson plan based on the Grade IV topic Healthy Body. Instructional media were six core AAC symbols (HEALTHY, SICK, BODY, WATER, DRINK, and IMPORTANT), picture cards, a communication board with twelve symbols, yes/no cards, and simplified visual learning materials. The verbal instructions were reduced to no more than three words and matched with pictures to suit the participant's visual learning characteristics. Direct Instruction was chosen as the instructional method because of its emphasis on explicit teaching, repeated modeling, and systematic scaffolding, which were considered suitable for beginning AAC users.

Cycle I consisted of three instructional meetings and a post-test. During the first meeting, the participant was introduced to six basic AAC symbols connected to body health. Each symbol was presented multiple times through digital displays and printed picture cards while the teacher simultaneously modeled the meaning of the symbol through gestures and facial expressions. Initially, the participant required continuous physical prompts to correctly identify symbols, but demonstrated increased visual attention to the instructional materials. At the second meeting three new symbols were added related to drinking water and healthy habits. The participant was able to sustain attention for a longer time and identify concrete symbols like WATER and DRINK more accurately than the previous session. However, problems occurred when complex visual materials with multiple pieces of information were presented at the same time. The participant was confused, took extra time to respond, and sometimes disengaged from the activity, showing that too much visual information was more than the participant could process. On the basis of these observations, instructional materials were revised in third meeting. Complex infographics were substituted with large individual picture cards, each featuring only one visual element. Additional opportunities were also given for independent use of the communication board. Although the participant continued to struggle with abstract concepts such as the main idea of a text, gains were observed in symbol recognition and communication behavior. By the end of the meeting, the participant spontaneously pointed to familiar symbols on the communication board without direct prompting, indicating the emergence of intentional communication via AAC.

Overall observation data indicated gradual improvement over the three instructional meetings but the pre-specified success criteria had not yet been achieved. Receptive communication improved as the participant's understanding of concrete symbols was reinforced through repeated exposure, while expressive communication remained relatively constant as the participant continued to depend heavily on teacher assistance. On the other hand, class participation increased steadily across the cycle suggesting that the visual features of low-tech AAC were effective in increasing engagement and motivation in learning activities.

Table 2. *Summary of Observation Results Across Cycle I*

Stage	Receptive Communication	Expressive Communication	Learning Participation	Total Score
Baseline	0.80	1.60	0.50	22.5%
Meeting 1	1.67	1.33	2.50	47.5%
Meeting 2	2.00	1.33	2.75	52.5%
Meeting 3	2.00	1.33	3.00	55.0%

Observations showed three important patterns. First, receptive communication improved steadily from 1.67 to 2.00, indicating that repeated exposure facilitated the development of symbol–meaning associations. Second, expressive communication was high (1.33) throughout the cycle because the participant was still in the initial input phase of AAC acquisition and used teacher prompts heavily. Third, the most significant improvement was found in learning participation, from 2.50 to 3.00, which means an enhanced engagement level with the visual learning activities in spite of the continued limitations of communication.

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At the end of Cycle I, a post-test consisting of ten communication tasks using AAC was administered. The participant obtained a total score of 6.75/10 (67.5%), indicating a considerable improvement compared to the baseline condition, but falling slightly below the established mastery criterion of 70%.

Table 3. *Summary of Cycle I Post-test Results*

Assessment	Score	Percentage	Category
Cycle I Post-test	6.75/10	67.5%	Developing

Analysis of the post-test responses showed that the participant was able to accurately identify the known concrete symbols such as WATER, DRINK, HEALTHY, particularly in the matching and yes/no response activities. However, the child continued to struggle with more complex communication skills including identifying the main idea of a visual text, combining two AAC symbols to create meaningful messages, and independently expressing information with multiple symbols. Results suggested the emergence of receptive communication, but the expressive communication was still in the emerging stage and needed more systematic intervention. Based on the observation data and the results of the post-test it can be seen that the Cycle I has not reached the predetermined success indicators. Only the classroom participation that has exceeded the expected criteria. However, the positive trend during the instructional meetings especially confirmed that the low-tech AAC intervention had a positive impact on the participant's communication development. The reflection showed that there were 4 main problems that needed to be improved in Cycle II, namely: (1) expressive communication was still highly dependent on the teacher's prompting; (2) visually dense instructional materials created cognitive overload; (3) symbol use was inconsistent in different learning contexts; and (4) peer communication opportunities were still limited. Cycle II was therefore redesigned by the introduction of systematic prompt fading, the simplification of visual materials, the introduction of adaptive picture stories and the introduction of structured peer-to-peer communication activities to promote greater communication independence.

Cycle II

Cycle II was structured based on the outcomes of the reflective activities of Cycle I. The changes are intended to retain the strengths of the previous cycle, and directly address the identified weaknesses. Four major improvements were made. First, the development of adaptive picture stories was based on the positioning of the participant (M.A.) as the main character to optimize engagement through self-identification. Second, the AAC communication board was redesigned with a color-coded layout to allow quicker access to symbols and to decrease visual processing load. Thirdly, to increase the communicative opportunities new vocabulary symbols related to health and nutrition were added. Finally, a systematic prompt fading protocol was used, reducing teacher assistance from physical prompts to gestural cues and delayed prompting. To promote communication independence, structured peer-to-peer communication activities, daily reinforcement sessions, and shorter instructional segments with active breaks were also incorporated. Cycle II comprised of three instructional meetings and a final post-test. In the fourth meeting the participant was involved in an adaptive picture story Maria and the Germ Monster, in which the participant took the role of the main character. This change had an immediate impact on emotional engagement, as demonstrated by spontaneous smiling, pointing toward the screen and sustained visual attention. Most importantly, the participant was able to successfully combine three AAC symbols (DIRTY → GERMS → STOMACHACHE) to communicate a simple narrative, which was above and beyond the planned target of combining only two symbols. Expressive communication was significantly better than Cycle I, but abstract concepts like FACT and OPINION were still difficult.

The fifth meeting focused on communication with peers using a second adaptive story, Maria and the Healthy Plate Island. The redesigned communication board enabled the participant to more efficiently locate symbols without additional orienting. For the first time, the participant was able to successfully communicate with a classmate by selecting and presenting the symbols VEGETABLES and EAT and the peer interpreted the symbols correctly. Another significant behavioral change was when the participant independently selected the symbol TIRED and pointed to herself, indicating emerging self-referential communication. This interaction indicated a major shift from the use of home signs for communication to the use of standardized visual symbols for functional communication in the context of an inclusive classroom. The sixth meeting was a consolidation meeting in preparation for the final assessment. The participant used structured flashcard activities to review previously taught symbols. The participant practiced communication with classmates using collaborative health-related tasks. In this session the participant acted as a "little teacher" by teaching the observer how to use AAC symbols and used AAC independently to regulate social interactions by stopping a peer from putting an unhealthy food symbol on the healthy plate. These behaviors indicated that AAC had moved from being a tool for responding to teacher prompts to a functional means of initiating and managing social communication.

The results from the observations revealed a significant improvement in all dimensions measured. Compared to Cycle I, where there was mainly development in classroom participation, Cycle II had balanced development in receptive communication, expressive communication, and active engagement." More and more independent AAC use was achieved by systematic fading, simplified visual materials, adaptive picture stories and peer communication opportunities.

Table 4. *Summary of Observation Results Across Cycle II*

Stage	Receptive Communication	Expressive Communication	Learning Participation	Total Score
End of Cycle I	2.00	1.33	3.00	55.0%
Meeting 4	2.67	2.00	3.25	67.5%
Meeting 5	2.67	2.33	3.25	70.0%
Meeting 6	3.00	2.67	3.25	75.0%

In Cycle II three major development patterns emerged. Receptive communication was first increased from 2.00 at the close

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of Cycle I to 3.00 by the final meeting, indicating successful consolidation of symbol recognition across different contexts with repeated exposure. Expressive communication increased incrementally from 1.33 to 2.67 . This indicates that the systematic fading protocol was successful in increasing communication independence after the AAC system was redesigned. Third, learning participation was consistently high across the cycle (3.25/4), showing continuous motivation and active classroom engagement. The final posttest was a 10 AAC-based communication tasks designed to assess symbol recognition, symbol combination, peer communication, and independent expressive communication. The participant scored 8.0 out of 10 points (80.0%) which exceeds the mastery criteria of 70% that was set.

Table 5. *Summary of Cycle II Post-test Results*

Assessment	Score	Percentage	Category
Cycle II Post-test	8.0/10	80.0%	Good

The participant was independently able to complete eight of the ten tasks including peer-to-peer communication and practical communication scenarios involving meaningful symbol combinations. The only remaining problems were higher-order language skills such as differentiating fact from opinion in abstract causal statements, and independently producing a full three-symbol narrative. Functional communication had increased dramatically, while higher abstract reasoning still needed more instructional support, as evidenced by the remaining errors. Cycle II has been successful in realizing all of the pre-set indicators of success. Receptive communication was 3.00/4 (75.0%) and expressive communication was improved to 2.67/4. Participation in learning was always high at 3.25/4 (81.3%) and the overall score of the observation was 75.0%. The final post-test score was increased to 80.0%. The findings indicate that the use of low-tech AAC was effective in enhancing both receptive and expressive communication within a real inclusive classroom situated in a resource-limited 3T area. But there were still some restrictions. The participant continued to have difficulty with abstract concepts that required causal reasoning, independent creation of longer symbolic messages and generalization of AAC use outside of the classroom environment. Despite these remaining challenges, the intervention was successful in converting the participant from a largely passive learner using home signs to an emerging functional communicator who was able to independently use AAC to participate in classroom learning and meaningful social interactions with teachers and peers.

Discussions

The results of this study indicate that the use of low-tech Augmentative and Alternative Communication (AAC) was successful in improving the receptive communication, expressive communication and classroom participation of a hearing-impaired fourth-grade student in an inclusive elementary school in a disadvantaged frontier and outermost (3T) region. The improvement was not only in the quantitative scores, but also in the qualitative changes of communication behaviour in the two action research cycles. The intervention gradually transformed the participant from a passive learner who depended mostly on home signs to an emerging functional communicator who could communicate messages with structured visual symbols during classroom learning. These findings suggest that AAC can be effective in bridging communication barriers when the design of AAC is aligned with the communication needs of individual learners and the learning environments in which they are situated. An important finding is the process of implementation itself. The intervention was not just a set of disconnected teaching strategies but a combination of several components that worked together to support each other such as simplified verbal instructions, incremental visual supports, systematic scaffolding, relevant communication contexts, and daily repeated practice. The power in these pieces seems to lie in their interplay rather than any single instructional strategy. This finding corroborates previous research indicating the importance of teachers' skills in conducting individualized needs assessment and modifying instructional materials based on students' communication characteristics for successful AAC intervention. The current study developed the low-tech AAC system specifically for the participant's visual learning profile and communication needs rather than using a standardized AAC template, thus increasing access to classroom instruction.

The enhancement of receptive communication was attributed to the re-design of visual learning materials in Cycle II. In Cycle I, the participant had difficulty processing instructional materials that contained more than one visual element at a time. Upon reflection, instructional materials were reduced to one visual element per learning task, greatly reducing undue cognitive load. The change was immediately followed by a marked improvement in receptive communication performance suggesting that the earlier difficulties experienced by the participant were not simply a matter of limited language ability but also of too much visual complexity. The findings are consistent with Cognitive Load Theory, which posits that when extraneous cognitive load is minimized, learners can devote more cognitive resources to meaningful learning and schema construction. Thus, the findings add to previous AAC research by showing the important role of visual design of communication materials in determining effectiveness of the intervention. The pattern of development for expressive communication was different. In contrast, expressive communication was fairly stable in Cycle I, with a large increase in Cycle II. This temporary plateau is not necessarily a sign that the intervention is not working, but may represent the initial phase of AAC learning. In the aided language modeling paradigm, new AAC users require frequent exposure to communication models to produce independent symbolic communication. The present study presented conditions to translate the previously acquired receptive knowledge into expressive communication by redesigning the communication board, using systematic prompt fading, and adaptive picture stories. Thus, expressive communication improved rapidly when the participant had sufficient opportunities to use AAC symbols independently in the context of authentic classroom interactions.

Another interesting finding is the rapid progress in classroom participation, which occurred prior to gains in both receptive and expressive communication. The introduction of visually structured AAC materials resulted in the participant's active engagement, suggesting that increased attention and motivation were prerequisites to subsequent communication development. This sequence is theoretically sensible because effective learning of language communication depends on continued interaction with the instructional input before comprehension and language production can be built. Classroom participation was also observed to shift from responding to teacher prompts to more proactive communication behaviors

such as initiating conversations, correcting peers, and showing AAC symbol use to others. Such qualitative behavioral changes point out to a better confidence and communication independence that cannot be fully appreciated with mere numbers of observation scores. The difference between Cycle I and Cycle II further validates the importance of reflective classroom action research. The gains seen in Cycle II cannot be explained by practice alone. Rather they were the result of systematic changes made after consideration. These included simplifying the visual stimuli, fading prompts systematically, individualising instructional stories, organising peer communication activities, and breaking instructional time into smaller chunks. Together these changes reduced cognitive load, increased emotional engagement, enabled independence in communication, and kept attention. The finding underscores the importance of continued instructional adaptations, rather than intervention intensity, in the successful implementation of AAC.

In summary, the present findings are aligned with previous studies reporting positive effects of AAC on communication development for individuals with complex communication needs. As in the results published by Ganz et al. (2021) and Leonet et al. (2022), the intervention was able to improve receptive and expressive communication. The present study, however, contributes further evidence by elucidating the mechanisms underlying such improvements in a real inclusive classroom and not in a clinical or laboratory setting. Furthermore, unlike many earlier studies in high-resource schools that have used high-technology AAC systems, this study shows that carefully designed low-tech AAC can lead to significant gains in communication even in schools with limited infrastructure and educational resources. These findings therefore provide practical evidence to support the feasibility of AAC implementation in disadvantaged educational contexts, particularly in the Indonesian 3T regions. There were also several contextual factors that contributed to the success of the intervention. The participant's high intrinsic motivation, supportive relationships with teachers and classmates, and well-developed fine motor skills facilitated active involvement throughout the study. On the other hand, lack of structured communication intervention over a period of 4 years, limited attention span and difficulty with the complex nature of abstract language concepts were major challenges during implementation. These results support the view that communication difficulties among students with hearing impairments are not just a consequence of hearing loss, but are also strongly influenced by access to appropriate communication systems and responsive educational environments. Therefore, early identification and timely AAC intervention should be priorities of inclusive education to reduce the long-term consequences of language deprivation.

In conclusion, this study contributes to the literature on inclusive education and AAC in a number of ways. In theory, it shows that the success of low-tech AAC is due to the interplay of the instructional design, cognitive processing, systematic scaffolding and meaningful social communication and not the communication medium alone. Practically, the study offers a replicable instructional framework of simplified visual materials, progressive AAC supports, prompt fading, peer-mediated communication, and repeated practice that can be implemented by regular classroom teachers without specialized technology. Most importantly, the findings add to the current evidence, by showing that classroom action research can be an effective framework to continuously improve AAC interventions in authentic inclusive classrooms, to support communication development for students with hearing impairments even in resource-scarce schools in the 3T regions of Indonesia.

CONCLUSION

The study concluded that the implementation of low-tech Augmentative and Alternative Communication (AAC) effectively improved the receptive and expressive communication skills of fourth-grade students with hearing impairment in an inclusive elementary classroom in 3T (disadvantaged, frontier, and outermost) areas. The intervention, which was implemented through two cycles of Classroom Action Research, gradually evolved from introducing single AAC symbols to incorporating adaptive picture stories, systematic prompt fading, color coded communication boards, and peer-mediated communication activities. Observable improvements were seen in receptive communication (20.0% to 75.0%), expressive communication (40.0% to 66.7%), and classroom participation as a result of the instructional changes. The final post-test score of 80.0% surpassed the mastery criterion. In addition to these quantitative gains, the participant demonstrated increased independence in communication, confidence and meaningful social interaction with peers. This suggests that low-tech AAC is an effective, practical and sustainable communication support strategy for inclusive schools in resource-limited settings. Based on these results, teachers are encouraged to systematically implement low-tech AAC into their daily classroom instruction with visual supports, gradual prompt fading, and structured peer communication activities in an effort to promote communication independence in students who are hearing impaired . Schools need to embed AAC into the framework of inclusive education programs by providing permanent communication boards, regular individualised intervention time and support teacher professional development for the implementation of AAC. Parents are also coached to practise AAC use at home within typical activities to facilitate generalisation of communication across settings. In conclusion, future research should include larger numbers of participants, investigate the maintenance and generalisation of AAC skills over time, and explore the effectiveness of low-tech AAC across a range of disability profiles in a range of inclusive educational settings.

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