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# Analysis of Assemblr Edu Media Use in Pre Reading Instruction Phase A Students with Intellectual Disabilities

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**A B S T R A C T**

Pre-reading is the foundational ability students must develop before entering formal reading instruction, yet Phase A students with intellectual disabilities frequently struggle to recognize letter symbols, distinguish visually similar letters, and connect letters with their sounds; prior studies of Augmented Reality media have measured learning outcomes but have not described how such media are actually used in special education classrooms. This study aims to describe the use of Assemblr Edu, an Augmented Reality application that presents material concretely and interactively, in pre-reading instruction, the pre-reading skills students demonstrate while learning with it, and the factors supporting and inhibiting its implementation among Phase A students with intellectual disabilities at SLB Negeri Langensari. The study employed a qualitative descriptive approach involving one classroom teacher and two students selected purposively. Data were collected through observation, interviews, performance assessment, informal tests, and documentation, and were analyzed using the interactive model of Miles, Huberman, and Saldaña, comprising data reduction, data display, and conclusion drawing and verification. Data trustworthiness was maintained through technique triangulation, source triangulation, and member checking. The findings show that students displayed better attention, engagement, and persistence during instruction with Assemblr Edu. Development was evident in recognizing vowel and consonant letters, imitating syllable sounds, and matching pictures to initial letters, although distinguishing visually similar letters remained difficult. Supporting factors comprised teacher competence, simple instructions, and appealing AR visualization, whereas inhibiting factors comprised unstable internet connectivity, environmental disturbance, and limited attention span. These findings imply that Augmented Reality media function effectively only when mediated by teacher facilitation and adequate technical support, and they offer special education teachers a process-level reference for designing concrete, interactive pre-reading instruction.

## INTRODUCTION

Education is a fundamental right of every citizen and plays an essential role in developing individual potential and improving quality of life. In Indonesia, the right to education is guaranteed for all citizens without discrimination, including students with special needs. This is affirmed in Article 5 paragraph (2) of the National Education System Act (Act No. 20 of 2003), which states that "citizens with physical, emotional, mental, intellectual, and/or social impairments are entitled to special education." This provision indicates that every student has the right to educational services appropriate to their characteristics and needs. The legal basis aligns with the constitutional mandate

of Article 28C paragraph (1) of the 1945 Constitution, which guarantees every individual the right to self-development through access to education for their welfare. Fulfilling the right to education therefore means more than ensuring school attendance; it requires guaranteeing adequate pedagogical accessibility. For students with special needs, this commitment demands adjustments in teaching methods so that instruction is not merely normative but also applicable and inclusive. Adapting instructional strategies is essential to address limitations in basic literacy so that every child has an equal opportunity to develop their intellectual potential. Differentiated instruction has been shown to significantly improve literacy outcomes because it accommodates the diversity of cognitive profiles and the specific needs of students (Al-Makahleh et al., 2023; Puzio et al., 2020). Furthermore, multisensory approaches that integrate visual, auditory, kinesthetic, and tactile stimulation play an important role in transforming abstract literacy concepts into more concrete learning experiences accessible to students with intellectual disabilities (Liang Soon et al., 2025).

One group of students requiring special education services is students with intellectual disabilities. Schalock et al. (2021) explain that intellectual disability is characterized by significant limitations in intellectual functioning and adaptive behavior encompassing conceptual, social, and practical skills, originating during the developmental period. This condition affects the learning process, particularly the mastery of basic academic skills, including pre-reading. Nevertheless, students with mild intellectual disabilities retain cognitive potential that can be optimized through appropriate and sustained pedagogical intervention (Jumriani et al., 2021). Providing reasonable accommodation is a prerequisite for their effective participation in an inclusive education ecosystem, encompassing curricular adaptation, flexible instructional strategies, and the provision of an accessible learning environment.

Pre-reading is the initial stage of literacy development that forms the foundation for subsequent reading ability. Roberts (2021) explains that pre-reading encompasses early literacy skills such as recognizing letter symbols, understanding letter-sound correspondence, and building alphabet knowledge as an essential foundation before students enter conventional reading. Among students with intellectual disabilities, these skills are frequently impeded by difficulties in recognizing letter symbols, distinguishing letters with nearly identical shapes, and associating letter symbols with their corresponding sounds. Such conditions mean that these students require instructional media that are concrete, engaging, interactive, and capable of providing learning experiences suited to their learning characteristics.

A preliminary study conducted by the researcher in November 2025 at SLB Negeri Langensari revealed that Phase A students with intellectual disabilities still experienced difficulties in recognizing letters, distinguishing similar letter shapes, and associating letter symbols with their phonetic sounds. Instruction dominated by conventional media left students less engaged and required more time for them to grasp pre-reading material. These problems indicate the need for instructional media innovation capable of delivering learning experiences in a more concrete, visual, and interactive manner.

These problems indicate that students with intellectual disabilities require instructional media capable of visualizing concepts concretely, capturing attention, and providing multisensory learning experiences. One medium with such characteristics is Assemblr Edu, an Augmented Reality-based application. Akçayır and Akçayır (2017) explain that Augmented Reality technology can enhance instructional quality by presenting material in a more concrete, contextual, and interactive manner, making abstract concepts easier to comprehend. Surani and Fricticarani (2023) add that Assemblr Edu is an Augmented Reality platform combining virtual objects with the real environment, enabling students to learn through engaging three-dimensional visualization. In addition, the visual and audio

features of the application can help students understand the relationship between letter shapes and letter sounds more meaningfully.

Several prior studies have demonstrated that Assemblr Edu exerts a positive influence on learning. Surani and Fricticarani (2023) found that the use of Assemblr Edu increased students' learning interest. Through development research, Sari and Handayani (2024) reported that Assemblr Edu is suitable for stimulating letter recognition in early childhood through engaging Augmented Reality visualization. Wulandari and Rozy (2025) subsequently demonstrated that Assemblr Edu affects the improvement of student learning outcomes by presenting material more concretely through three-dimensional visualization. Another study by Ningsih et al. (2025) likewise showed that Assemblr Edu can improve letter recognition among students identified as slow learners.

These studies, however, have generally employed quantitative approaches focused on measuring media effectiveness based on improvements in learning outcomes, letter recognition, or learning interest. They have not provided an in-depth account of how Assemblr Edu is actually used during instruction, particularly among students with intellectual disabilities. Research describing the pre-reading skills that emerge during the learning process and identifying the factors that support and inhibit the implementation of such media in special education contexts also remains limited. Yet information on the instructional process, student responses, and the supporting and inhibiting factors of media implementation is essential as a basis for developing instruction suited to the characteristics of students with special needs.

Addressing this gap is urgent for two reasons. First, Phase A is the formative window in which alphabet knowledge is established; when pre-reading skills are not consolidated at this stage, students with intellectual disabilities carry the deficit forward into every subsequent level of literacy instruction (Roberts, 2021). Second, Augmented Reality applications are increasingly adopted in Indonesian schools, including special schools, without documented guidance on how such media should be deployed for students whose attention span, visual discrimination, and information-processing capacity are constrained. Teachers therefore require process-level evidence, namely what the teacher does, how students respond, and which technical and environmental conditions must be met, rather than effectiveness figures alone. Describing the implementation of Assemblr Edu in an authentic special school classroom responds directly to this need.

The novelty of this study lies in its use of a qualitative descriptive approach to examine the implementation of Assemblr Edu in pre-reading instruction for Phase A students with intellectual disabilities, a perspective not yet pursued by prior studies, which have been predominantly quantitative and outcome oriented. By positioning the instructional process as the focus of inquiry, this study offers a deeper perspective on the use of Augmented Reality technology in pre-reading instruction for students with intellectual disabilities.

Accordingly, this study aims to describe the use of Assemblr Edu in pre-reading instruction for Phase A students with intellectual disabilities at SLB Negeri Langensari, to portray the pre-reading skills students demonstrate while learning with this medium, and to identify the factors that support and inhibit its use. The findings are expected to serve as a reference for special education teachers in designing pre-reading instruction that is more concrete, interactive, and attuned to the characteristics of students with intellectual disabilities.

## METHODS

This study employed a qualitative descriptive approach. As Creswell and Poth (2023) note, qualitative research takes place in a natural setting, positions the researcher as the primary instrument, draws on multiple data sources, and applies inductive analysis that emphasizes the interpretation of

meaning rather than generalization. This approach was chosen because the research objectives require an in-depth description of processes unfolding in the classroom, namely the use of Assemblr Edu in pre-reading instruction, the pre-reading skills of Phase A students with intellectual disabilities, and the factors supporting and inhibiting its implementation at SLB Negeri Langensari.

The study was conducted at SLB Negeri Langensari, Banjar City, West Java Province. The site was selected based on a preliminary study indicating that the school had already used Assemblr Edu in pre-reading instruction for students with intellectual disabilities. Data collection ran from February to May 2026, covering preparation, data collection, data analysis, and report writing.

The research subjects comprised one classroom teacher and two Phase A students with intellectual disabilities, selected through purposive sampling, that is, the deliberate selection of subjects based on the research objectives. The participating students were those who had received pre-reading instruction but had not yet mastered the skill optimally according to the teacher's initial assessment, as indicated by difficulties in recognizing letter symbols, distinguishing letters with similar shapes, and associating letter symbols with their sounds. The classroom teacher was selected because she taught Indonesian language, used Assemblr Edu in pre-reading instruction, and was willing to serve as an informant throughout the study.

The researcher served as the primary instrument (human instrument), while supporting instruments in the form of observation guidelines, interview guidelines, performance assessment sheets, informal tests, and documentation were used to gather data systematically (Creswell & Poth, 2023). These supporting instruments were developed around three research variables. The media use variable was elaborated into the aspects of teacher competence, student response, and persistence, with indicators comprising the teacher's ability to operate Assemblr Edu independently, the provision of instructions for using the medium, students' attention and response to Augmented Reality objects, and students' participation through to the completion of activities. The pre-reading variable encompassed visual, phonological, and associative aspects, with indicators comprising the recognition of letter symbols, discrimination between letters with similar shapes, imitation of letter or syllable sounds modeled by the teacher, and the matching of three-dimensional images to their corresponding letter symbols. The supporting and inhibiting factors variable focused on technical and environmental aspects, with indicators comprising device availability and the smoothness of AR object loading, the adequacy of screen brightness, and classroom conditions supporting the use of the medium.

Data were collected through observation, interviews, performance assessment, informal tests, and documentation. Observation was conducted non-participantly on the delivery of pre-reading instruction using Assemblr Edu. The researcher observed and recorded the emergence of teacher and student behaviors based on the prepared observation guidelines, covering the teacher's operation of the medium, students' responses to Augmented Reality objects, and the technical and environmental conditions of the classroom during the activities. Semi-structured interviews were conducted with the classroom teacher to elicit information beyond the reach of observation, namely the teacher's considerations in preparing and delivering material, her appraisal of student responses, and the obstacles encountered during the use of the medium (Sugiyono, 2018).

Performance assessment was used to evaluate students' persistence in completing learning activities with Assemblr Edu. Assessment was carried out through observation of performance using a four-point rubric ranging from unable to complete the task to completing the task independently. This technique was chosen on the basis of authentic assessment, which evaluates the application of knowledge and skills through tasks resembling real situations and thus yields a more comprehensive picture of student ability (Adie et al., 2018; Sokhanvar et al., 2021).

Informal tests were used to measure students' pre-reading skills before and after instruction with Assemblr Edu, covering the recognition of vowel and consonant letters, discrimination between

letters with similar shapes, imitation of syllable sounds, and the matching of images to their initial letters. The tests were constructed by the researcher together with the teacher and were not bound by the standardized procedures of formal testing, allowing them to be adapted to the characteristics of students with special needs (Efendi, 2018; Sunardi & Sunaryo, 2017). Documentation in the form of photographs of instructional activities was collected at every session to record the delivery of instruction and to serve as supporting material for technique triangulation (Sugiyono, 2018).

Data trustworthiness was maintained through technique triangulation, source triangulation, and member checking (Sugiyono, 2018). Technique triangulation involved cross-checking data from observation, interviews, performance assessment, informal tests, and documentation to examine consistency across findings. Source triangulation involved comparing information from the classroom teacher with data obtained directly from the students so that findings did not rest on a single source. Member checking was conducted by confirming the findings with the classroom teacher as the principal informant to ensure that the researcher's interpretations corresponded to actual conditions in the field.

Data were analyzed using the interactive model of Miles, Huberman, and Saldaña, which proceeds continuously from data collection through to conclusion drawing. In the reduction stage, data from all techniques were selected and organized, retaining material relevant to the research focus, namely media use, students' pre-reading skills, and the supporting and inhibiting factors. The reduced data were then displayed as descriptive narrative, tables, and documentation to facilitate the identification of emerging patterns and meanings. The final stage comprised conclusion drawing, verified continuously through the triangulation procedures described above, with interpretation focused on the three areas of research inquiry.

## RESULTS AND DISCUSSION

The findings and their discussion are presented in an integrated manner following the three areas of inquiry: the process of using Assemblr Edu, the pre-reading skills students demonstrated, and the factors supporting and inhibiting its use. Data were obtained through observation, interviews, performance assessment, informal tests, and documentation involving one classroom teacher (EY) and two Phase A students with intellectual disabilities, AG and TM.

1. Students' Initial Pre-Reading Skills

Prior to the use of Assemblr Edu, the researcher conducted initial observation and informal testing to establish students' pre-reading skills.

Observation showed that AG and TM still had difficulty recognizing letters consistently. AG could name several vowels but frequently confused them when asked to point to a particular letter. TM, meanwhile, could recognize only some vowels and still required verbal prompting from the teacher.

In terms of visual discrimination, both students frequently struggled to distinguish letters with similar shapes, such as b and d and p and q. Neither could yet consistently match pictures of objects to their corresponding initial letters.

The classroom teacher explained:

"Before we used Assemblr Edu, the students often got bored quickly when learning letters with ordinary letter cards. They frequently forgot letters that had been introduced earlier and struggled to distinguish letters with nearly identical shapes." (EY, interview, 2026)

These findings indicate that the students still required more concrete and engaging media to support pre-reading instruction.

2. The Use of Assemblr Edu in Pre-Reading Instruction

The observation sheet used four categories to describe the emergence of the behaviors observed during instruction. The category not emerging was assigned when the target behavior was not displayed during the activity. The category emerging with assistance was assigned when the behavior appeared only after the teacher or researcher provided full assistance. The category partially emerging was used when the behavior began to appear but still required assistance, direction, or verbal prompting from the teacher. The category emerging independently was assigned when the student displayed the behavior independently and consistently throughout the activity.

These categories served as a guide in describing the observation results, facilitating the depiction of students' behavioral development during the use of Assemblr Edu in pre-reading instruction.

Table 1. Observation Score Criteria

| Score | Category | Description |
|---|---|---|
| **1** | Not Emerging | Behavior not observed during instruction |
| **2** | Emerging with Assistance | Behavior emerges after full assistance |
| **3** | Partially Emerging | Behavior emerges with assistance or verbal prompting |
| **4** | Emerging Independently | Behavior emerges independently and consistently |

Source: Research data (2026)

As shown in Table 1, the observation scores served as a reference for describing the extent to which students' behaviors emerged during instruction. Higher scores indicate greater independence in displaying the observed behavior. These categories helped the researcher interpret the observation results consistently rather than describing behavior only in general terms.

Table 2. Observation Results on the Use of Assemblr Edu

| No | Observation Indicator | Category |
|---|---|---|
| **1** | Teacher operates Assemblr Edu without assistance | Emerging Independently |
| **2** | Teacher delivers simple instructions | Emerging Independently |
| **3** | Student sustains eye contact with the screen | Partially Emerging |
| **4** | Student attempts to touch AR objects | Emerging Independently |
| **5** | Student sustains focus on AR objects | Partially Emerging |
| **6** | Smooth loading of AR objects | Partially Emerging |
| **7** | Adequate screen brightness | Emerging Independently |
| **8** | Minimal environmental disturbance | Partially Emerging |

Source: Observation data (2026)

As shown in Table 2, most observation indicators fell into the emerging independently and partially emerging categories. This suggests that Assemblr Edu could be implemented effectively by the teacher, while students began to display attention, engagement, and interaction with the medium, although several indicators still required direction or reinforcement from the teacher.

Over the course of instruction, both students displayed gradual changes in learning behavior compared with their conduct when conventional media were used. In the early sessions, AG still required the teacher's direction to focus on the screen and tended to shift attention when AR objects first appeared. After the teacher provided a demonstration and an opportunity to interact with the medium, AG began to show curiosity by approaching the device, pointing at three-dimensional letter objects, and repeatedly attempting to touch the objects on screen. When the letter "B" appeared, AG spontaneously pointed at it while saying "be," then repeated the letter sound after receiving reinforcement from the teacher.

A comparable change was observed in TM. At the outset, TM was easily distracted by the surrounding environment and attended to the medium only intermittently. After the teacher displayed AR objects several times accompanied by simple, repeated instructions, TM became able to sustain

attention on the screen for several minutes, follow the teacher's directions to observe the displayed objects, and respond when asked to name letter sounds or match pictures to their initial letters.

Observation indicates that the use of three-dimensional objects through Assemblr Edu gradually increased students' attention, engagement, and responsiveness during instruction. Compared with initial conditions, both students appeared more enthusiastic, sustained focus for longer periods, responded more frequently to the teacher's instructions, and showed greater willingness to interact with the instructional medium.

The interview results reinforced these observational findings. The teacher regarded Assemblr Edu as an engaging medium well suited to the characteristics of students with intellectual disabilities.

The teacher stated:

*"The students appear far more interested when letters appear in three-dimensional form. Usually they look briefly and then lose focus, but with Assemblr Edu they want to keep watching the objects that appear." (EY, interview, 2026)*

The teacher further explained:

*"Instructions have to be kept short. If they are too long the students find them hard to follow. With Assemblr Edu I only need to say 'look at the letter,' 'touch the letter,' or 'say the sound.'" (EY, interview, 2026)*

The teacher nonetheless noted technical obstacles.

"The most frequent obstacle is an unstable internet connection, which sometimes makes the AR objects appear more slowly." (EY, interview, 2026)

These findings indicate that Assemblr Edu could be implemented effectively by the teacher and was received positively by the students. This occurred because the medium rendered letter symbols, otherwise abstract, as three-dimensional objects that could be observed more concretely. For students with intellectual disabilities, concretely presented information is easier to grasp than two-dimensional symbols. Moving, visually appealing AR objects also sustained attention for longer, leaving students more receptive to information, while the teacher's simple, incremental instructions helped reduce their cognitive load when learning letters.

These findings align with Garzón and Acevedo (2019), who state that Augmented Reality technology exerts a positive influence on learning by presenting visual objects more concretely and interactively. Akçayır and Akçayır (2017) likewise explain that three-dimensional visualization helps students comprehend abstract concepts, rendering learning more meaningful. Correspondingly, Ibáñez and Delgado-Kloos (2018) note that AR-based learning integrates visual, auditory, and kinesthetic experience, thereby increasing students' cognitive engagement. The heightened attention and engagement observed in this study therefore stem not solely from the use of AR technology but also from the correspondence between the medium's characteristics and the learning needs of students who require concrete, multisensory experience.

3. Students' Pre-Reading Skills During the Use of Assemblr Edu

Students' persistence in completing learning activities was assessed through performance assessment, with results presented in Table 3.

Table 3. Performance Assessment Results for Persistence

| Name | Score | Category |
|---|---|---|
| **AG** | 4 | Emerging Independently |
| **TM** | 3 | Partially Emerging |

Source: Assessment data (2026)
Score descriptors:
Score 1 = Unable to complete the task
Score 2 = Completes the task with full assistance

Score 3 = Completes the task with verbal direction
Score 4 = Completes the task independently

As shown in Table 3, AG obtained a score of 4 (emerging independently), while TM obtained a score of 3 (partially emerging). Both students were thus able to follow learning activities using Assemblr Edu, though their degrees of independence differed. AG completed all activities without assistance, whereas TM still required verbal direction at several stages. This suggests that Assemblr Edu can help increase students' persistence, while the need for support continues to vary according to individual characteristics.

Students' developing pre-reading skills were subsequently traced through informal tests administered before and after instruction.

Table 4. Comparison of Pre-Reading Skills Before and After the Use of the Medium

| Indicator | Before | After |
|---|---|---|
| Recognizing vowel and consonant letters | Some letters recognized | Most letters recognized |
| Distinguishing b-d and p-q | Frequently confused | Still difficult but improved |
| Imitating syllable sounds | Requires repeated modeling | Able to imitate more consistently |
| Matching pictures to initial letters | Not yet consistent | More accurate and quicker |

Source: Informal test data (2026)

Table 4 shows development in pre-reading skills across all observed indicators following the use of Assemblr Edu. The clearest changes appear in letter recognition, syllable sound imitation, and the matching of pictures to initial letters. Although discriminating between letters with similar shapes remained difficult, the students showed improvement relative to their condition before instruction.

Beyond these four techniques, documentation in the form of photographs of instructional activities was used to record each session. The documentation captured students' seating positions while observing AR objects, the teacher's handling of the device, and students' engagement as they touched and pointed at three-dimensional letter objects. This material served to corroborate the observation and performance assessment data through technique triangulation

Table 5. Informal Pre-Reading Test Results

| Indicator | AG | TM | Mean |
|---|---|---|---|
| Recognizing vowel and consonant letters | 4 | 3 | 3.5 |
| Distinguishing b-d and p-q | 3 | 2 | 2.5 |
| Imitating syllable sounds | 4 | 3 | 3.5 |
| Matching pictures to initial letters | 4 | 3 | 3.5 |

Source: Informal test data (2026)

As shown in Table 5, the highest mean scores were obtained on the indicators of recognizing vowel and consonant letters, imitating syllable sounds, and matching pictures to initial letters, each reaching 3.5. The indicator of discriminating between b-d and p-q obtained the lowest mean, 2.5, with AG scoring 3 and TM scoring 2. The informal test results, corroborated by observation and performance assessment, indicate that students' pre-reading skills developed over the course of instruction with Assemblr Edu. This development is evident in letter recognition, syllable sound imitation, and the matching of pictures to their corresponding initial letters.

In the early sessions, AG frequently hesitated when asked to name letters already covered and several times needed the teacher's help to recall letter names. As the teacher displayed letter objects through Assemblr Edu repeatedly, AG began to respond more confidently, attending to the three-dimensional objects and attempting to name letters before the teacher modeled the pronunciation. On several occasions AG recognized the displayed letter and produced its sound independently. The informal tests likewise showed that AG began to recall letters covered in earlier sessions without always requiring the teacher's assistance.

A similar development was observed in TM. At the outset, TM could recognize only some vowels and often stopped when asked to name the next letter. As instruction progressed, TM began to show interest in the AR objects and responded more frequently to the teacher's questions. When

the teacher displayed pictures of objects through Assemblr Edu, TM became able to match several pictures to their corresponding initial letters and to name several consonants that had previously not been recognized consistently. Although TM's responses still required verbal reinforcement, they represented development relative to initial conditions.

Both students nonetheless continued to struggle with visual discrimination, particularly in distinguishing letters with nearly identical shapes such as b and d and p and q. On several occasions they still confused these letters when naming or selecting them, requiring the teacher to provide modeling, repetition, and incremental reinforcement.

This development occurred because, during instruction, students gained experience connecting letter shapes, letter sounds, and object representations simultaneously. Three-dimensional visualization helped them build associations between letter symbols and objects familiar from everyday life, rendering letter recognition more meaningful. Repeated use of the medium also afforded opportunities to revisit learning experiences through visual, auditory, and kinesthetic stimuli, reinforcing memory for letter shapes and sounds, although attainment differed across students according to individual characteristics.

Conversely, the difficulty in distinguishing letters with nearly identical shapes appears related to the limitations in visual discrimination commonly found among students with intellectual disabilities. Although Assemblr Edu clarified letter forms through three-dimensional visualization, distinguishing highly similar shapes still requires repeated practice, teacher guidance, and consistent learning experience.

These findings support Ningsih et al. (2025), who showed that Assemblr Edu can improve letter recognition among students identified as slow learners. This study, however, offers a deeper account: the development of pre-reading skills is shaped not only by the medium itself but also by students' interaction with it, the intensity of repetition, and the teacher's guidance throughout instruction.

4. Supporting and Inhibiting Factors in the Use of Assemblr Edu

The principal supporting factors in the use of Assemblr Edu for pre-reading instruction comprised the teacher's competence in operating the application, the use of simple instructions, and the appeal of the Augmented Reality (AR) objects displayed. These factors contributed to the smooth conduct of instruction by complementing one another in accommodating the learning characteristics of students with intellectual disabilities.

Teacher competence emerged as the foremost supporting factor because the teacher acted not merely as a user of the medium but as a facilitator determining how it was deployed to meet student needs. She adjusted the presentation of material, delivered instructions incrementally, repeated explanations when students encountered difficulty, and reinforced the responses that emerged. These strategies helped students grasp the learning activities more systematically and thus follow instruction more effectively. Short, simple instructions further reduced the information-processing burden on students with intellectual disabilities, who typically have limited capacity to process complex directions.

The three-dimensional, interactive AR objects also functioned as a supporting factor by holding students' attention longer than conventional media. Concrete visualization afforded a more tangible learning experience, making it easier for students to connect letter shapes with their sounds. Where attention could be sustained, engagement in learning rose accordingly, allowing pre-reading skills to develop more effectively. This finding aligns with Garzón and Acevedo (2019), who explain that the successful application of Augmented Reality in education depends on the quality of instructional design, the teacher's role as facilitator, and the capacity to integrate technology with

students' needs and characteristics, thereby yielding positive effects on learning outcomes and engagement.

The study also identified several inhibiting factors, evident in Table 2, where the indicators for smooth AR object loading and minimal environmental disturbance fell into the partially emerging category, and corroborated by the teacher's account of unstable internet connectivity. These inhibiting factors comprised unstable internet connectivity, occasionally slow loading of AR objects, disturbances in the learning environment, and students' limited attention span.

Disturbances in the learning environment also affected the effective use of the medium, as students with intellectual disabilities tend to have limited attention spans and are readily distracted by surrounding stimuli. When disturbances arose from outside the classroom, or when pauses occurred because of technical difficulties, students found it harder to maintain focus and required repeated direction and reinforcement from the teacher to re-engage with the activity.

The supporting factors nonetheless proved more dominant than the inhibiting ones. This is evident in the teacher's capacity to overcome various obstacles through simple instructions, repetition of material, and guidance throughout instruction. Given adequate devices, stable internet connectivity, and teacher competence in managing instruction, Assemblr Edu holds considerable potential as an alternative medium for supporting the development of pre-reading skills among students with intellectual disabilities.

## DISCUSSION

Taken together, the three areas of inquiry point to a single interpretation: Assemblr Edu supported pre-reading development not by virtue of the technology itself, but by restructuring the way pre-reading content was presented to students whose cognitive processing is constrained. The discussion below interprets each finding in relation to relevant theory and to studies published over the past five years.

The increase in students' attention, engagement, and persistence is consistent with the cognitive theory of multimedia learning, which holds that learning is more effective when information is processed simultaneously through the visual and the verbal channel, so that the load is distributed rather than concentrated in one channel (Mayer, 2021). The three-dimensional objects of Assemblr Edu presented letter shapes visually while the teacher and the application supplied the corresponding sounds, so that students received the same information through two complementary channels. Read alongside cognitive load theory, which distinguishes the load imposed by the material itself from the load imposed by the manner of its presentation (Sweller et al., 2019), the teacher's short and simple instructions can be understood as a reduction of extraneous load: attention that would otherwise be spent decoding complex directions remained available for the pre-reading task. This interpretation also accords with Liang Soon et al. (2025), who report that multisensory approaches integrating visual, auditory, and kinesthetic stimulation support letter recognition among students with special educational needs.

The pattern of development observed, namely progress in recognizing vowel and consonant letters, imitating syllable sounds, and matching pictures to initial letters alongside persistent difficulty in distinguishing visually similar letters, can be read through Roberts's (2021) account of letter learning, in which alphabet knowledge develops unevenly because letter naming, letter-sound correspondence, and the visual discrimination of similar graphemes are partly separate accomplishments. The finding converges with Ningsih et al. (2025) and Sari and Handayani (2024), who both report gains in letter recognition through Assemblr Edu, and with Wulandari and Rozy (2025), who attribute improved learning outcomes to concrete three-dimensional visualization. It further converges with Saunders et al. (2025), who found that Augmented Reality video models overlaid on printed words increased phoneme and word reading among first-grade students with

developmental delays, indicating that such media can support the phonological dimension of early reading and not only visual letter recognition. The residual difficulty with letters such as b and d or p and q, which Adhe et al. (2024) attribute to direction confusion in the visual recognition of mirror-image letters among young children, however, marks a boundary to what visualization alone can accomplish: consistent with the characterization of intellectual disability as a significant limitation in intellectual functioning and adaptive behavior originating during the developmental period (Schalock et al., 2021), fine visual discrimination appears to require repeated practice and sustained teacher guidance beyond what a single medium can supply.

The dominance of teacher competence among the supporting factors, and of technical and environmental conditions among the inhibiting ones, supports the meta-analytic conclusion of Garzón and Acevedo (2019) that the learning gains associated with Augmented Reality depend on instructional design and the teacher's role as facilitator rather than on the technology in isolation. Where Surani and Fricticarani (2023) document a rise in learning interest, the present study specifies the conditions under which such interest is realized in a special school classroom: stable connectivity, adequate devices, a low-distraction environment, and a teacher who segments instructions and reinforces emerging responses. This reading is reinforced by Yilmaz Yenioglu et al. (2024), who report that the benefit of an Augmented Reality intervention for students with learning disabilities depended on how the material was structured for them, and by Khoirunnisa et al. (2024), who show that Augmented Reality supports reading skills most effectively when its presentation is personalized to the individual learner's profile. Assemblr Edu therefore operates as a mediating tool whose contribution is contingent on pedagogical management.

The academic contribution of this study lies in shifting the study of Assemblr Edu from measured outcomes to the instructional process. Prior research, predominantly quantitative and outcome oriented (Al-khresheh et al., 2024; Sari & Handayani, 2024; Saunders et al., 2025; Surani & Fricticarani, 2023; Wulandari & Rozy, 2025), establishes that Augmented Reality media can improve letter recognition and learning outcomes, but leaves unexplained how that improvement comes about. By describing teacher facilitation, student response, and the technical and environmental conditions of implementation in an authentic special school setting, this study offers an empirically grounded account of the mechanism through which Augmented Reality supports pre-reading development among students with intellectual disabilities, and extends the application of multimedia learning and cognitive load principles to a population rarely examined within this literature. For practice, it supplies special education teachers with a process-level reference; for scholarship, it provides the descriptive basis on which subsequent experimental or longitudinal studies of Augmented Reality in special education can be built.

This study has several limitations that warrant attention in interpreting its findings. First, the number of subjects was very small, involving only one teacher and two Phase A students with intellectual disabilities, so the findings cannot be generalized to all students with comparable characteristics. Second, the study employed a qualitative descriptive approach focused on understanding the process of using Assemblr Edu in pre-reading instruction. It was therefore not designed to measure the effectiveness of the medium or to compare learning outcomes statistically before and after its use. Third, the study period was relatively brief and thus cannot capture the long-term effect of Assemblr Edu on the development of pre-reading skills. Reading ability among students with intellectual disabilities requires repeated and sustained practice, so further research of longer duration is needed. Fourth, the use of Assemblr Edu remained subject to technical factors such as internet stability, device specifications, and classroom conditions. These factors may affect the smooth implementation of the medium and students' learning experience during instruction. Considering these limitations, further research is recommended to involve a larger number of

subjects, adopt a longer study period, and combine qualitative and quantitative approaches in order to obtain a more comprehensive picture of the use of Assemblr Edu in instruction for students with intellectual disabilities.

## CONCLUSION

This study yields three conclusions addressing its areas of inquiry. First, with respect to the process of media use, the teacher was able to operate Assemblr Edu independently and deliver simple instructions suited to students' characteristics, while students displayed gradually increasing attention and engagement throughout instruction. The use of Augmented Reality (AR) technology through three-dimensional visualization fostered students' attention, engagement, and persistence, creating a more concrete and interactive learning experience. Second, with respect to pre-reading skills, students showed development in recognizing vowel and consonant letters, imitating syllable sounds, and matching pictures to initial letters, whereas distinguishing letters with similar shapes still requires sustained guidance. Third, with respect to the factors affecting implementation, the smooth use of the medium was supported by teacher competence, simple instructions, and the appeal of AR objects, while the obstacles comprised unstable internet connectivity, disturbances in the learning environment, and students' limited attention span. Assemblr Edu may therefore serve as a promising alternative medium for supporting the development of pre-reading skills among students with intellectual disabilities, to the extent captured by the instructional process observed in this study.

In light of these findings, teachers are encouraged to draw on Assemblr Edu as an alternative medium for pre-reading instruction, adapted to students' characteristics and needs. Schools are expected to provide support through adequate facilities and infrastructure, including instructional devices and stable internet connectivity, and to facilitate teacher training in the use of Augmented Reality (AR) media. Further research is recommended to involve a larger number of subjects, adopt a longer study period, and extend inquiry into the use of Assemblr Edu across other literacy domains such as early reading, writing, and vocabulary development, so as to yield more comprehensive findings that strengthen the use of technology in special education.

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