Volume: 28, Number: 1, April 2026, pp. 111-124
p-ISSN: 1410-8771, e-ISSN: 2580-4812
https://doi.org/10.37303/likhitaprajna.v28i1.973

LIKHITAPRAJNA Jurnal Ilmiah
Fakultas Keguruan dan Ilmu Pendidikan

EARLY NUMERACY LEARNING BASED ON VIGNETTE ACTIVITY SEQUENCE (VAS) USING NUMBER BOARDS FOR STUDENTS WITH CEREBRAL PALSY

Jessica Aspasyah Henda Arianto[1] , Nia Wahyu Damayanti[2]
[1]Surabaya State University, Surabaya, Indonesia, jessica.22136@mhs.unesa.ac.id
[2]Surabaya State University, Surabaya, Indonesia, niadamayanti@unesa.ac.id

ARTICLE INFO

Article history:
Received March 2026
Revised March 2026
Accepted March 2026
Published 2 April 2026

Keywords:
Cerebral Palsy
Early Numeracy
Vignette Activity Sequence
Inclusive Mathematics Education

To cite this article:
Arianto, J., & Damayanti, N. (2026). Early Numeracy Learning Based on Vignette Activity Sequence (VAS) Using Number Boards for Students with Cerebral Palsy. *Jurnal Likhitaprajna*, *28*(1), 111-124. https://doi.org/10.37303/likhitaprajna.v28i1.973

ABSTRACT

This study aims to explore the early numeracy learning process of a student with cerebral palsy (CP) through the Vignette Activity Sequence (VAS) using a magnetic number board as an adaptive manipulative medium, focusing on the student's engagement, obstacles encountered, and responses at each stage of the activity. A qualitative single case study design was employed, involving one 12 year old female student with spastic quadriplegic CP at a special education elementary school in Surabaya, Indonesia. Data were collected through a task analysis-based observation sheet, field notes, and video documentation during a single structured learning session, then analyzed using the Miles and Huberman model with triangulation across all three data sources. The findings revealed that the student actively engaged in all VAS stages despite significant fine motor difficulties, consistently demonstrating counting-on ability, while counting-back ability did not emerge verbally. The adaptive magnetic number board and contextual narrative effectively supported cognitive, motor, and affective engagement, with movement fluency improving through repeated interaction. The study concludes that VAS combined with adaptive manipulative media has strong potential to support inclusive early numeracy learning for students with CP through meaningful, multisensory, and structured mathematical experiences.

Corresponding Author:
Nia Wahyu Damayanti
Surabaya State University, Surabaya, Indonesia; niadamayanti@unesa.ac.id

INTRODUCTION

Access to quality education for children with disabilities remains a serious challenge at the global level (Odeh & Lach, 2024). In its 2020 Global Education Monitoring Report, UNESCO revealed that many education systems worldwide have not yet been able to adequately accommodate the diverse needs of students (Team, 2020). At least a quarter of countries still segregate educational services for children with special needs, and in Asia and Latin America, the figure exceeds 40 percent. This situation is exacerbated by a lack of teacher training, infrastructure that is not yet disability-friendly, and curricula that are not responsive to differences in student abilities (Malizal & Rahman, 2024; Somad et al., 2024; Waisath et al., 2024). Similar conditions also exist in Indonesia, Similar conditions also exist in Indonesia. Mathematics learning for students with special needs within the context of inclusive education still faces various challenges, ranging from curriculum adaptation to teaching strategies that do not yet fully address students' individual needs (Efendi et al., 2022; Maryam et al., 2024; Mulia & Yanti, 2025; Prathama et al., 2022; Woolfson, 2024). These challenges underscore the urgent need for more inclusive and responsive educational approaches that recognize every student's right to learn according to their individual potential and needs.

One group of children with special needs who require special attention and the fulfillment of their rights is children with physical disabilities caused by cerebral palsy (CP). CP is a permanent neurological disorder resulting from brain damage that occurs before, during, or after birth, affecting motor control, muscle tone, movement coordination, and body posture (Duman, 2022; Kumar et al., 2023; Salomon, 2024; Yang et al., 2021). In CP, the impact of early brain injury extends beyond paralysis or spasticity to various functional aspects. It is this combination of motor and sensory impairments that subsequently makes it difficult for children to fully engage in daily activities, play, learn, and participate socially (Baiardi & Battistin, 2022; Chiu et al., 2023; Giannoni, 2022; Trevarrow et al., 2022; Warutkar et al., 2023).

In CP, fine motor skills are not just about hand movements; they are closely linked to how children learn, are assessed, and understand concepts, including mathematics. Many academic tasks rely on manipulating objects and writing symbols, so fine motor difficulties can mask actual cognitive abilities (Cabral et al., 2023; El-Latif et al., 2023; Micheletti et al., 2024; Twum, 2025). This condition is exacerbated by the fact that the severity of CP varies from person to person, requiring learning strategies and materials that are truly responsive to each student’s specific needs (Cheng et al., 2021; Fondo et al., 2025; Mohamed et al., 2025; Wotherspoon et al., 2023).

These barriers directly impact students with CP’s mastery of basic mathematical skills, particularly in early numeracy (Feldberg et al., 2021; Neveu et al., 2023). Early numeracy encompasses basic skills such as counting, ordering numbers, understanding the concepts of more and less, and representing numbers using concrete objects, competencies that form the foundation for long-term mathematical development (Jordan et al., 2022; Morsanyi et al., 2024). However, in school learning practices, early numeracy skills among students with CP often do not develop optimally (Nelwan et al., 2021). Feldberg et al.(2021) explain that students with CP tend to face challenges in aspects of numerical cognition, including understanding quantity, recognizing relationships between numbers, and representing numbers mentally or concretely.

This challenge is further complicated by the fact that early numeracy essentially requires the ability to connect numerical symbols with concrete representations, understand number sequences, and gradually construct an understanding of quantity (Chen et al., 2024; Malone et al., 2021). These conditions indicate that students with CP require mathematics instruction that provides concrete, multisensory, structured, and gradual learning experiences, specifically through manipulative learning materials, clear scaffolding, and adjustments to the pace of learning to ensure students can remain actively engaged (Atanasius, 2016; Damayanti et al., 2024; Rizky et al., 2024). In this context, the role of learning media becomes crucial, as appropriate media not only serve as visual aids but also as a bridge between the physical experiences accessible to students with CP and the mathematical concepts to be developed (Ingkavara & Yasri, 2025; Nurjanah et al., 2021; Rachmat et al., 2023).

The use of concrete materials not only helps students understand mathematical concepts but also supports student engagement throughout the learning process (Ahmad & Siller, 2024; Tran & Duong, 2023). In line with this, various studies indicate that mathematics instruction for students with special needs requires a concrete, visual, and structured approach. Nurjanah et al.(2021) explain that hands-on activity-based learning materials help students understand basic mathematical concepts through manipulative activities and direct learning experiences. For students with cerebral palsy (CP), such an approach is crucial because it allows them to learn through visual support and physical interaction that better aligns with their motor characteristics. Additionally, Neveu et al.(2023) note that students with CP require mathematics learning strategies tailored to their motor limitations and working memory, so the use of concrete aids and structured activities can help students build foundational numeracy understanding more effectively.

On the other hand, organizing structured learning activities also plays a crucial role in helping students understand mathematical concepts step by step. One approach with the potential to address this need is the Vignette Activity Sequence (VAS). VAS is a series of activities based on short narratives that realistically depict learning situations and are used as stimuli to elicit discussion, reflection, and contextual mathematical reasoning (Crisan & Geraniou, 2025; Skilling & Ivars, 2021). Through a structured sequence of activities, VAS enables students to engage cognitively in analyzing the presented situations, identifying problems, and developing alternative ways of thinking (Zhang et al., 2025). Furthermore, this approach facilitates the process of connecting concrete experiences with more meaningful conceptual understanding, ensuring that learning is not merely procedural but also helps students actively construct mathematical meaning (Shelton et al., 2021).

Some previous studies have shown that the VAS has been widely utilized in the context of teacher education and the development of teaching practices. Crisan & Geraniou (2025) used the VAS to help mathematics teachers reflect on the instructional decisions they made during the teaching process. Meanwhile, Skilling & Stylianides (2023) utilized the VAS to examine mathematics teachers' beliefs regarding the promotion of students' cognitive engagement through classroom situations presented narratively. These various studies underscore the potential of VAS as a rich framework for fostering reflection, contextual reasoning, and active engagement in mathematics learning. However, all of these studies still position teachers or pre-service teachers as the primary subjects. No study has directly examined how the VAS approach can be applied in the student learning process, specifically how students with special needs process and interact with manipulative media in each stage of VAS activities in early numeracy learning at special education elementary schools.

Therefore, this study aims to explore the early numeracy learning process among students with CP through the use of number line media based on the VAS approach at SDLB. Using a qualitative case study approach, this study seeks to uncover how students with CP engage with manipulative media at each stage of VAS activities, the obstacles that arise, and the students' responses to the implemented learning structure. The findings of this study are expected to contribute to the development of more inclusive and adaptive mathematics learning practices for students with CP, while also serving as a study that directly adapts the VAS approach within the context of student learning at SDLB schools in Indonesia.

METHOD

This study employs a qualitative approach aimed at gaining an in-depth understanding of a phenomenon based on experience (Creswell, 2013) using a single case study design. This design was chosen because the research objective is to obtain a deep and comprehensive understanding of the early numeracy learning process based on the Vignette Activity Sequence (VAS) using a magnetic number board with a student with cerebral palsy. A single-case study is a research approach used to study a single case in depth within a real-life context when the boundary between the phenomenon and its context is not clearly defined (Yin, 2018). This approach allows the researcher to understand the learning process in its entirety, including the subject's responses, obstacles, and engagement during the activity.

The focus of this study is a student with cerebral palsy at a special education school in Surabaya. The subject was selected through purposive sampling based on characteristics aligned with the study's objectives, namely having fine motor limitations in the hands and feet and using a wheelchair for daily mobility. Purposive sampling allows the researcher to select participants based on specific characteristics relevant to the study's focus (Memon et al., 2025).

Research Subjects

The subject of this study is a 12 year old female student, identified as A, who is in the second grade at a special education school (SLB) in Surabaya. In terms of the curriculum, A is in Phase A, with learning outcomes equivalent to those of the early grades of elementary school. The subject has been diagnosed with cerebral palsy (CP), which affects her motor skills and mobility.

Based on information from the teacher and in accordance with the literature on CP classification, A falls under the category of spastic quadriplegia, a condition in which motor impairments affect all four limbs, resulting in complete dependence on a wheelchair for mobility, accompanied by fine motor impairments in both hands that hinder full control of movement, as well as involvement of the oral muscles that impacts speech articulation and hypersalivation (Panteliadis, 2018; Prabha et al., 2021). Nevertheless, A possesses functional verbal communication skills, although her articulation is unclear, she is able to understand simple instructions and respond verbally during learning interactions.

In an academic context, A has acquired basic counting skills but still requires verbal and physical assistance to perform them. Socially and emotionally, A displays a cheerful personality and enthusiasm for participating in learning activities. She is able to maintain her attention well, listen carefully to instructions, and demonstrate active engagement during activities despite her motor limitations. The subject was selected through purposive sampling because her profile of motor impairments and academic status aligns with the research focus: exploring the process of early numeracy learning through VAS based manipulative media among students with cerebral palsy.

Learning Media Design

The learning material used in this study is a magnetic number line board adapted from the concrete number lines commonly used in elementary mathematics education, which was then modified to suit the characteristics and needs of students with cerebral palsy (CP) who have motor impairments. The board is made of cardboard covered with flannel fabric, featuring numbers 0 through 5 equipped with a magnetic system, producing a "click" sensation when the object is moved, serving as tactile feedback to help students concretely understand number movement and sequence. The main object being moved is a paper snail figurine with a small handle on the back so that students with CP can easily grasp it. As activity targets, contrasting-colored flannel flowers are placed at specific number points to clarify visual focus and increase learning motivation.

Vignette Activity Sequence (VAS) Design

The instructional design is based on the Vignette Activity Sequence (VAS) approach, a narrative-based strategy that guides students through a series of concrete activities within a meaningful context. In this study, VAS is embedded in the story "The Magic Snail Watering Flowers," in which students are asked to move the snail character to specific numbers to water the flowers according to the story's plot. This approach integrates visual, tactile, and motor aspects, making early numeracy learning more concrete, multisensory, and inclusive. The learning stages consist of seven VAS activities as presented in the following table.

Table 1. VAS Sequence

VAS Activities	Activity Description
Introduction to the Story and the Magical Snail Character	Students are introduced to the story of the Magic Snail, who carries a small watering can to water the flowers. Students point to the flowers posted on the board and help place the snail on the number 0.
Initial Instructions	The researcher explains the mission objective, which is to water the pink flower at number 2. Students point to the flower's location and listen to the numbers they will pass through.
Mission: Watering the Pink Flower at Number 2	Students move the snail from the number 0 to the number 2 while saying the numbers it passes through. Upon arrival, students water the flower.
Mission: Water the Brown Flower at Number 5	Students move the snail from number 2 to 5, saying the numbers in order, then water the brown flower.
Advanced Challenge: Watering the Blue Flower at Number 0	Students return to the number 0, count backward, and then water the blue flowers.
Closing and Reflection	Students review the numbers they have covered, identify the flower locations, receive praise, and engage in a brief reflection.

Research Instruments

The primary instrument in this study is a task analysis-based observation sheet designed in accordance with the activity stages in the VAS. Task analysis is used to break down skills into small steps so that they are easier for students with special needs to learn (Irvan, 2024). The observation sheet was designed to record the subject's performance on each activity, covering indicators such as the ability to name numbers, recognize flower colors, and guide the snail character to a specific number point. The recorded results are categorized into three categories: Independent (performed without assistance), With Assistance (performed with verbal or physical guidance), and Not Performed (no response to instructions). In addition to the observation sheet, data is also collected through field notes and video documentation during the learning process.

Data Analysis Techniques

Data analysis in this study refers to the (Miles et al., 2014) which comprises three stages: data reduction, data presentation, and drawing conclusions and verification. In the data reduction stage, the researcher filtered and focused the data from observation sheets, field notes, and video documentation on A's activities and responses during VAS-based learning.

In the data presentation stage, the findings were organized into a descriptive narrative that outlined A's involvement in each stage of the activity, including interactions with the media, responses to instructions, and the influence of motor skills on the learning process. In the conclusion and verification stage, the researcher interpreted the response patterns and forms of support required by A during learning, then linked the findings to relevant theories. Data validity was established through triangulation of observation results, field notes, and video documentation to ensure the consistency and accuracy of the collected information.

RESULTS AND DISCUSSION

RESULTS

This section presents the research findings regarding subject A's early numeracy learning process through the six stages of the Vignette Activity Sequence (VAS) using a magnetic number board as a teaching aid. The research results are presented chronologically based on observational data, field notes, and video documentation recorded during the learning process.

Table 2. Subject A's Learning Process at Each VAS Stage

VAS Activities	Counting Skills	Media Manipulation	Affective Engagement	Level of Independence
Story and Character Recognition	Counting 1–5 (one-to-one correspondence)	Pointing to flowers with a finger	Enthusiastic and responsive	I
Giving initial instructions	-	Watching a demonstration of how to use the media	Very enthusiastic ("Wow!")	I
Mission: Water the pink flowers (0-2)	Counting: "zero, one, two"	Slow and stiff movements, but able to gradually control the snail	Get involved ("The flowers are wet!")	A
Mission: Water the pink flowers (0–2)	Counting: "two, three, four, five"	Movements are still slow but more stable	Demonstrating self-monitoring ("Blue flower!")	A
Mission: Watering the blue flowers (5-0)	Verbal counting backward has not yet emerged	Movements are smoother than in the previous stage	Remains actively engaged	A
Closing and reflection	Independent counting: "zero, one, two"	Moving the snail more smoothly and independently	Very enthusiastic and showing spontaneous initiative	N

Activity 1: Introduction to the Story and the Magical Snail Character

The researcher introduced a magnetic number board depicting a flower garden with five flowers of different colors. A was asked to point to and count the number of flowers on the board. A was able to count all five flowers independently while pointing to them one by one with a finger.

Figure 1. A Points to The Location of The Flowers on The Magnetic Number Board While Naming The Colors of The Flowers He Recognized

When asked about their favorite flower color, A immediately responded and pointed to the pink flower on the board. At this stage, A did not require verbal or physical assistance from the researcher.

Activity 2: Providing Initial Instructions

The researcher introduced the snail character that would water the flowers and demonstrated the process of filling the snail teapot with water. A showed great enthusiasm, even spontaneously expressing her admiration. "Wow!" exclaimed A, as he watched the process of filling the snail teapot with water.

Figure 2. The Researcher Demonstrates The Process of Filling Water Into The Snail Teapot as Part of The Introduction to The VAS Storyline

A appeared to be watching the demonstration closely and was ready to enter the story without needing further instructions.

Activity 3: The Mission to Water the Pink Flower at Number 2

A was asked to move the snail from the number 0 to the number 2 while saying the numbers they passed. A faces significant motor difficulties in grasping and moving the snail due to high muscle tone in both hands, causing the movement to proceed more slowly. Nevertheless, A is able to move the snail gradually and call out the numbers as they are passed. "Zero... one... two..." A, while moving the snail from the number 0 to the number 2.

Figure 3. A Moves The Snail Character from The Number 0 to The Number 2 While Stating The Sequence of Numbers Passed

Figure 4. A Waters The Pink Flower Using The Snail Teapot With Verbal Assistance from The Researcher

A's articulation was somewhat unclear but consistent and understandable to the researcher. To water the flowers, A needed verbal assistance from the researcher because of difficulty lifting the snail-shaped teapot independently. After successfully watering the flowers, A spontaneously stated, "The flowers are wet!" A, after successfully watering the pink flowers.

Activity 4: Mission: Water the Brown Flower at Number 5

A continued moving the snail from the number 2 to the number 5. Motor difficulties were still evident, but A kept trying and maintained enthusiasm. A was able to name the numbers in sequence as the snail passed them. "Two, three, four, five..." A said as she moved the snail from the number 2 to the number 5.

Figure 5. A Moves The Snail Character from The Number 2 to The Number 5 on The Magnetic Number Board
Figure 6. A Waters The Chocolate Flower Using The Snail Teapot With Verbal Assistance from The Researcher

The process of watering the brown flowers again required verbal assistance from the researcher. As a break, the researcher asked which flowers had not yet been watered, and A actively responded. “The blue flower!” A replied to the researcher’s question about which flowers had not yet been watered.

Activity 5: Advanced Challenge: Watering the Blue Flower at Number 0

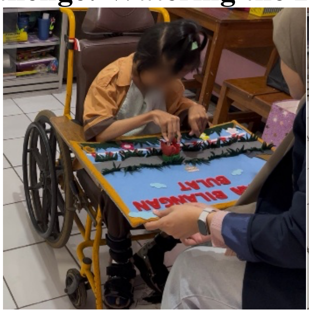

Figure 7. A Moves The Snail Character from Number 5 Back Toward Number 0 to Water The Blue Flower
Figure 8. A Waters The Blue Flower Using The Snail’s Watering Can With from The Researcher

A was asked to move the snail from the number 5 back to the number 0 to water the blue flower. Compared to the previous stages, A showed improved fluency in moving the snail. However, at this stage, A did not mention the numbers passed in reverse during the movement. The process of watering the blue flower still required verbal assistance from the researcher.

Activity 6: Closing and Reflection

The researcher praised A for successfully helping the snail water all the flowers. A was not asked to repeat the numbers that had been passed, but spontaneously asked to water the pink flower, her favorite, using the remaining water in the pitcher. A then moved the snail from number 0 to number 2 while saying, “Zero, one, two.” A independently moved the snail to her favorite flower.

Figure 9. A Independently Moved The Snail Toward The Pink Flower and Watering it Again as A form of Spontaneous Initiative During The Reflection Stage

The researcher linked the activity to everyday experiences and asked A if she had ever seen her mother watering flowers. A replied that she had not, so this activity became a meaningful experience that connected learning to real-life contexts. The session concluded with praise and appreciation.

DISCUSSION

The findings of this study describe the process of early numeracy learning among students with cerebral palsy (CP) through the Vignette Activity Sequence (VAS) approach using a magnetic number board in depth. The results of the analysis are organized into the following four discussion dimensions.

Mathematics Learning in Students with CP

A's learning process throughout the VAS session reflects the typical complexity seen in students with spastic quadriplegia, in which motor, cognitive, and communication impairments coexist but vary in intensity at each stage. Student A's fine motor impairment consists of high muscle tone, resulting in stiff and difficult-to-control hand movements that consistently affect the speed and independence in manipulating materials, particularly in grasping and moving the snail and lifting the watering can to water the flowers. This aligns with the findings of Micheletti et al. (2024) , which confirm that for students with CP, fine motor impairments often mask their true cognitive abilities, as many academic tasks rely on object manipulation, which is precisely their primary area of difficulty.

In addition, the articulation difficulties experienced by A, resulting from muscle involvement, affect the clarity of her verbalization of numbers, although this does not prevent A from continuing to try to say them. This condition underscores the importance of designing instruction that not only accommodates motor limitations but also provides opportunities for students with CP to demonstrate their conceptual understanding through more accessible modalities (Feldberg et al., 2021; Neveu et al., 2023).

Development of Counting Skills

Throughout the learning session, A consistently demonstrated the counting on strategy, the ability to continue counting sequentially from a specific number (Malone et al., 2021). This was evident in Activity 3 when A said "zero, one, two" and in activity 4 when A said "two, three, four, five" as the snail moved along the number line. This ability became even stronger in the closing activity, when A independently and without being asked moved the snail from the number 0 to the number 2 while stating the correct number sequence. This is an indication that the concept of counting on is beginning to form for the small number range that has been practiced repeatedly (Malone et al., 2021).

Conversely, the ability to count backward had not yet emerged verbally in Activity 5 when A was asked to count backward from 5 to 0. This absence was most likely due to limitations in working memory and divided attention. A appeared to allocate all of her cognitive focus to controlling motor movements, making it impossible to simultaneously verbalize the numbers in reverse (Feldberg et al., 2021). This finding indicates that counting backward requires more explicit and step by step activity design in subsequent learning sessions, separate from demanding motor tasks.

The Role of Manipulative Media in the Learning Process

Magnetic number line materials play a crucial role in supporting A's engagement during the learning process. The magnetic system, which produces a "click" sensation at each number point, provides tactile feedback that helps A understand positional shifts, even when their motor control is not precise. This aligns with the principles of multisensory learning, which emphasize the importance of engaging more than one sensory modality, visual, tactile, and motor, in supporting the understanding of basic mathematical concepts among students with special needs (Nurjanah et al., 2021; Tran & Duong, 2023). Additionally, the adaptive design of the media, featuring small handles on the snail that facilitate a secure grip, demonstrates that physical modifications to manipulative materials can reduce access barriers without diminishing the educational value they offer (Neveu et al., 2023).

Most significantly, the improvement in the fluency of Movement A observed in Activity 5 compared to previous activities indicates motor adaptation to the medium through repetition. This is consistent with the principle of motor learning that the gradual repetition of structured physical activities can build more automatic movement patterns even when muscle tone remains high (Cheng et al., 2021; Rachmat et al., 2023). These findings reinforce the argument that adaptively designed manipulative media can separate motor barriers from the cognitive abilities of students with CP, thereby allowing their true academic potential to emerge and be facilitated (Micheletti et al., 2024; Neveu et al., 2023).

Effectiveness of the VAS Narrative Context

The narrative context of the VAS, presented in the story "The Magic Snail Watering the Flowers," proved effective in building and sustaining A's motivation to learn throughout the session. From the introductory stage, A's personal engagement, finding their favorite colored flower on the board, created an emotional connection that served as a driver for active participation in subsequent stages. Spontaneous responses such as "Wow!" upon seeing the water being poured and "The flower is wet!" after successfully watering the flower indicate that A was not merely following instructions but was genuinely and meaningfully engaged in the story's flow. This aligns with the VAS principle, which positions contextual narratives as stimuli to simultaneously foster students' cognitive and affective engagement(Crisan & Geraniou, 2025; Shelton et al., 2021). Student A's ability to answer correctly when asked which flower had not been watered, "The blue flower!", demonstrates that A is capable of monitoring the progress of their own activities and actively maintaining an understanding of the story's context throughout the learning session, indicating a deeper level of cognitive engagement than merely following instructions(Crisan & Geraniou, 2025; Skilling & Stylianides, 2023).

The most significant finding emerged at the end of the session, when A took the initiative to water her favorite flower without being asked, then moved the snail while counting "zero, one, two" on her own. This initiative confirmed that the VAS narrative successfully encouraged active engagement. This aligns with previous research showing that engaging and meaningful context-based mathematics learning approaches have proven effective in increasing the engagement of students with special needs (Damayanti et al., 2024; Nurjanah et al., 2021; Skilling & Stylianides, 2023).

CONCLUSION

This study explores the early numeracy learning process of a student with cerebral palsy (CP) using the Vignette Activity Sequence (VAS) approach with a magnetic number board at a special education elementary school. The findings indicate that Subject A was able to actively participate in all stages of the VAS activities despite facing significant motor impairments, with varying patterns of engagement at each stage.

Specifically, subject A consistently demonstrated the ability to count forward within the range of 0–5, by the end of the session, A was even able to recite the sequence of numbers independently without being prompted, an early indication of the internalization of the concept of counting. Conversely, the ability to count backward had not yet emerged verbally, indicating the need for more explicit and step-by-step activities to support this skill in subsequent sessions. The fine motor difficulties consistently experienced by A affected the speed of media manipulation, but did not hinder their cognitive and affective engagement; in fact, there was an increase in the fluency of movement as the activity was repeated, reflecting motor adaptation to the media. The VAS narrative context proved effective in building motivation and maintaining A's engagement throughout the session, as reflected in the spontaneous responses and initiatives that emerged without prompting.

This study offers several important implications. First, the VAS approach, which has long been used in the context of teacher professional development, has proven to be effectively adaptable as a framework for hands-on learning activities for students with CP. Second, manipulative materials designed to be adaptive, taking into account the motor limitations of students with CP, can separate physical barriers from cognitive abilities, thereby allowing students' academic potential to be recognized and supported. Third, a personal and meaningful narrative context is a crucial element in designing inclusive mathematics learning for students with CP.

This study has the limitation of involving a single subject in a single learning session; therefore, the findings should be generalized with caution. Further research involving longer sessions, a more diverse group of subjects, and a more structured integration of the "counting back" stage is highly recommended to deepen our understanding of the effectiveness of the VAS approach in early numeracy learning for students with CP.

ACKNOWLEDGMENTS

The authors would like to express sincere gratitude to Dr. Nia Wahyu Damayanti, M.Pd. for her valuable guidance, support, and constructive feedback throughout this research. Appreciation is also extended to the Department of Mathematics Education, Universitas Negeri Surabaya, for providing academic support and research facilities. The authors would also like to thank the principal, teachers, and staff of a special school in Surabaya for their cooperation during the data collection process. Special appreciation is addressed to the student participant and the family for their participation, trust, and support throughout the study.

REFERENCES

Ahmad, S., & Siller, H. S. (2024). Investigating the effect of manipulatives on mathematics achievement: The role of concrete and virtual manipulatives for diverse achievement level groups. *Journal on Mathematics Education*, *15*(3), 979–1002. https://doi.org/10.22342/jme.v15i3.pp979-1002

Atanasius, E. P. (2016). *Modul Guru Pembelajar PLB Tunadaksa Kelompok Kompetensi H*. Pusat Pengembangan dan Pemberdayaan Pendidik dan Tenaga Kependidikan Bidang Taman Kanak-kanak & Pendidikan Luar Biasa, Direktorat Jenderal Guru dan Tenaga Kependidikan.

Baiardi, V., & Battistin, T. (2022). *The Child With Cerebral Palsy and Visual Impairment*. 401–435. https://doi.org/10.1007/978-3-030-85619-9_11

Cabral, T. I., Pan, X., Tripathi, T., Jianing, & Heathcock, J. (2023). Manual Abilities and Cognition in Children with Cerebral Palsy: Do Fine Motor Skills Impact Cognition as Measured by the Bayley Scales of Infant Development? *Behavioral Sciences*, *13*. https://doi.org/10.3390/bs13070542

Chen, C.-C., Berteletti, I., & Hyde, D. (2024). Neural evidence of core foundations and conceptual change in preschool numeracy. *Developmental Science*. https://doi.org/10.1111/desc.13556

Cheng, M., Anderson, M., & Levac, D. (2021). Performance Variability During Motor Learning of a New Balance Task in a Non-immersive Virtual Environment in Children With Hemiplegic Cerebral Palsy and Typically Developing Peers. *Frontiers in Neurology*, *12*. https://doi.org/10.3389/fneur.2021.623200

Chiu, H., Ada, L., Cherng, R., & Chen, C. (2023). Relative contribution of sensory and motor impairments to mobility limitations in children with cerebral palsy: an observational study. *Scientific Reports*, *13*. https://doi.org/10.1038/s41598-023-30293-9

Creswell, J. W. (2013). *Qualitative Inquiry & Research Design : Choosing Among Five Approaches* (3rd ed.). SAGE Publications, Inc.

Crisan, C., & Geraniou, E. (2025). Designing for actively engaging with mathematics education research in mentoring practice: a Vignette Activity Sequence approach. *Educational Technology Research and Development*, *0123456789*. https://doi.org/10.1007/s11423-025-10538-2

Damayanti, N. W., Yuniarto, E., Mura, E. R., & Bachtiar, A. H. (2024). *Development of Mathematics Song Lyrics on Whole Numbers for Students With Special Needs*. *16*, 5770–5783. https://doi.org/10.35445/alishlah.v16i4.5692

Duman, K. (2022). Cerebral Palsy: An Overview. *Hamidiye Medical Journal*, *3*(1), 1–6. https://doi.org/10.4274/hamidiyemedj.galenos.2021.72792

Efendi, M., Pradipta, R. F., Dewantoro, D. A., Ummah, U. S., Ediyanto, E., & Yasin, M. H. M. (2022). Inclusive Education for Student with Special Needs at Indonesian Public. *International Journal of Ins*, *15*(2), 967–980. https://doi.org/https://doi.org/10.29333/iji.2022.15253a

El-Latif, A. S. A., Kamal, H., & Attia, M. (2023). Correlation between Cognitive Abilities and Fine Motor Skills in Children with Hemiparetic Cerebral Palsy. *The Egyptian Journal of Hospital Medicine*. https://doi.org/10.21608/ejhm.2023.292763

Feldberg, S. C. de F., Cardoso, T. da S. G., Santos, F. H., Muszkat, M., Bueno, O. F. A., & Berlim de Mello, C. (2021). Numerical cognition in children with cerebral palsy. *Research in Developmental Disabilities*, *119*(September 2020), 1–9. https://doi.org/10.1016/j.ridd.2021.104086

Fondo, H. K., Obinga-Ogono, S., & Okutoyi, J. (2025). The Relationship between Resource Adaptation and the Teaching of Functional Skills to Learners with Cerebral Palsy in Special Units in Kilifi County. *Greener Journal of Educational Research*. https://doi.org/10.15580/gjer.2025.1.051625084

Giannoni, P. (2022). *Sensory-Motor and Perceptual Problems in Cerebral Palsy*. 237–262. https://doi.org/10.1007/978-3-030-85619-9_6

Ingkavara, T., & Yasri, P. (2025). Evaluating the Efficacy of an Integrative Instructional Framework in Mathematics Education for Students. *European Journal of Mathematics and Science Education*. https://doi.org/10.12973/ejmse.6.1.51

Irvan, M. (2024). *Penerapan Metode Task Analysis dalam Meningkatkan Kemampuan Bina Diri Mencuci Tangan Murid Down Sydnrome di SLBN 1 Selayar*. Universitas Negeri Makassar.

Jordan, N. C., Devlin, B. L., & Botello, M. (2022). Core foundations of early mathematics: refining the number sense framework. *Current Opinion in Behavioral Sciences*, *46*, 101181. https://doi.org/https://doi.org/10.1016/j.cobeha.2022.101181

Kumar, K., Rai, D. K., & Vyas, P. P. (2023). Ayurvedic Management of Cerebral Palsy: Review of Literature. *International Journal of Health Sciences and Research*. https://doi.org/10.52403/ijhsr.20231008

Malizal, Z. Z., & Rahman, N. A. (2024). Breaking Boundaries in Inclusive Education: A Narrative Review of Pedagogical, Technological, and Policy Practices and Challenges in Regular Schools. *Sinergi International Journal of Education*. https://doi.org/10.61194/education.v2i3.588

Malone, S., Pritchard, V., & Hulme, C. (2021). Separable effects of the approximate number system, symbolic number knowledge, and number ordering ability on early arithmetic development. *Journal of Experimental Child Psychology*, *208*, 105120. https://doi.org/10.1016/j.jecp.2021.105120

Maryam, Nasrullah, A., & Aliyah, S. R. (2024). Implementasi Pendidikan Inklusif pada Siswa Berkebutuhan Khusus. *Journal of Instructional and Development Researches*, *4*(5), 418–430.

Memon, M. A., Ramayah, T., Ting, H., & Cheah, J. (2025). *Purposive Sampling: A Review And Guidelines For Quantitative Research*. *9*(1). https://doi.org/10.47263/JASEM.9(1)01

Micheletti, S., Galli, J., Vezzoli, M., Scaglioni, V., Agostini, S., Calza, S., Merabet, L. B., & Fazzi, E. (2024). Academic skills in children with cerebral palsy and specific learning disorders. *Developmental Medicine & Child Neurology*, *66*(6), 778–792. https://doi.org/10.1111/dmcn.15808

Miles, M. B., Huberman, A. M., & Saldaña, J. (2014). *Qualitative Data Analysis: A Methods Sourcebook* (Third, Vol. 17). SAGE Publications, Inc.

Mohamed, N., Ibrahim, M. B., El-agamy, O. A., Aldhahi, M. I., & Elsebahy, S. Y. (2025). Effects of Core Stability Training on Balance, Standing, and Gait in Children with Mild Cerebral Palsy: A Randomized Controlled Trial. *Healthcare*, *13*(11), 1–13. https://doi.org/https://doi.org/10.3390/healthcare13111296

Morsanyi, K., Peters, J., Battaglia, E., Sasanguie, D., & Reynvoet, B. (2024). The causal role of numerical and non-numerical order processing abilities in the early development of mathematics skills: Evidence from an intervention study. *Current Research in Behavioral Sciences*, *6*, 100144. https://doi.org/https://doi.org/10.1016/j.crbeha.2023.100144

Mulia, E., & Yanti, I. (2025). Service Managements for Children with Special Needs in Schools Organising Inclusive Education. *ICMIE Proceedings*. https://doi.org/10.30983/777yhx21

Nelwan, M., Bos, I. F.-V. Den, Vissers, C., & Kroesbergen, E. (2021). The relation between working memory, number sense, and mathematics throughout primary education in children with and without mathematical difficulties. *Child Neuropsychology*, *28*, 143–170. https://doi.org/10.1080/09297049.2021.1959905

Neveu, M., Geurten, M., & Rousselle, L. (2023). Training arithmetical skills when finger counting and working memory cannot be used: A single case study in a child with cerebral palsy. *Applied Neuropsychology: Child*, *12*, 367–379. https://doi.org/https://doi.org/10.1080/21622965.2023.2170798

Nurjanah, N., Rohayati, A., & Riza, L. (2021). A Learning Media Based on Hands-on Activity in Mathematics for Students Special School. *IJDS: Indonesian Journal of Disability Studies*. https://doi.org/10.21776/ub.ijds.2021.008.02.02

Odeh, K. B., & Lach, L. M. (2024). Barriers and Challenges Affecting Quality Education (Sustainable Development Goal #4) in Sub-Saharan Africa by 2030. *Public Health*, *11*. https://doi.org/10.3389/fpubh.2023.1294849

Panteliadis, C. P. (2018). *Cerebral Palsy: A Multidisciplinary Approach* (3rd editio). Springer. https://doi.org/10.1007/978-3-319-67858-0

Prabha, J., Alam, A., Kumar, C., Kumar, R., & Kohli, N. (2021). Neuroradiologic Features Associated With Severe Restriction of Functional Mobility in Children With Cerebral Palsy in North India. *Journal of Child Neurology*, *36*, 711–719. https://doi.org/10.1177/0883073821993613

Prathama, S. K., Kusumaningrum, S. R., & Dewi, R. (2022). Problem with The Implementation of Inclusive Education for Student with Special Needs in Public Schools. *SENTRI: Jurnal Riset Ilmiah*. https://doi.org/10.55681/sentri.v1i4.316

Rachmat, F., Yufiarti, Y., Jamaris, M., & Mulyadi, S. (2023). Improving The Fine Motor Ability of Children With Cerebral Palsy Through Contextual Learning Based on Maze Game Media. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*. https://doi.org/10.31004/obsesi.v7i6.5172

Rizky, V. M., Nurhastuti, Iswari, M., & Mahdi, A. (2024). Effectiveness of Counting Box Learning Media to Improve the Ability to Sum Numbers 1-10 for Children with Cerebral Palsy. *EDUMASPUL Jurnal Pendidikan*, *8*(1), 302–306. https://doi.org/https://doi.org/10.33487/edumaspul.v8i1.7590

Salomon, I. (2024). Neurobiological Insights Into Cerebral Palsy: A Review of the Mechanisms and Therapeutic Strategies. *Brain and Behavior*, *14*. https://doi.org/10.1002/brb3.70065

Shelton, R. N., Kerschen, K., & Wilkerson, T. L. (2021). The examination of a vignette activity sequence in a secondary mathematics methods course. *School Science and Mathematics*, *121*(1), 2–12. https://doi.org/https://doi.org/10.1111/ssm.12445

Skilling, K., & Ivars, P. (2021). Using vignettes in Mathematics teacher education and reserach: The role of knowledge and beliefs. *Proceedings of the 19th Biennial Conference of the European Association for Research on Learning and Instruction (EARLI 2021)*.

Skilling, K., & Stylianides, G. J. (2023). Using vignettes to investigate mathematics teachers' beliefs for promoting cognitive engagement in secondary mathematics classroom practice. *ZDM - Mathematics Education*, *55*(2), 477–490. https://doi.org/10.1007/s11858-022-01431-w

Somad, A., Haryanto, S., & Darsinah, D. (2024). Inclusive Education for Special Needs Students in Indonesia: A Review of Policies, Practices and Challenges. *JMKSP (Jurnal Manajemen, Kepemimpinan, Dan Supervisi Pendidikan)*. https://doi.org/10.31851/jmksp.v9i2.16192

Team, G. E. M. R. (2020). *Global Education Monitoring Report 2020: Inclusion and Education: All Means All*. UNESCO. https://doi.org/https://doi.org/10.54676/JJNK6989

Tran, T. A., & Duong, V. (2023). Improving Mathematics Learning Outcomes Using Concrete Props in Grade V Elementary School Students. *IRAONO: Journal of Elementary and Childhood Education*, *1*(1), 8–15. https://doi.org/10.56207/iraono.v1i1.115

Trevarrow, M., Taylor, B., Reelfs, A., Wilson, T., & Kurz, M. (2022). Aberrant movement-related somatosensory cortical activity mediates the extent of the mobility impairments in persons with cerebral palsy. *The Journal of Physiology*, *600*. https://doi.org/10.1113/jp282898

Twum, F. (2025). Relationship between Motor Skills and Intellectual Functioning in Learners with Cerebral Palsy. *African Journal of Humanities and Contemporary Education Research*. https://doi.org/10.62154/ajhcer.2025.019.01013

Waisath, W., McCormack, M., Stek, P., & Heymann, J. (2024). Dismantling barriers and advancing disability-inclusive education: an examination of national laws and policies across 193 countries. *International Journal of Inclusive Education*, *28*(10), 2088–2103. https://doi.org/10.1080/13603116.2022.2058623

Warutkar, V., Kovela, R., & Samal, S. (2023). Effectiveness of Sensory Integration Therapy on Functional Mobility in Children With Spastic Diplegic Cerebral Palsy. *Cureus*, *15*. https://doi.org/10.7759/cureus.45683

Woolfson, L. (2024). Is inclusive education for children with special educational needs and disabilities an impossible dream? *The British Journal of Educational Psychology*, *95*, 725–737. https://doi.org/10.1111/bjep.12701

Wotherspoon, J., Whittingham, K., Sheffield, J., & Boyd, R. N. (2023). Cognition and learning difficulties in a representative sample of school-aged children with cerebral palsy. *Research in Developmental Disabilities*, *138*(February), 104504. https://doi.org/10.1016/j.ridd.2023.104504

Yang, H. J., Zhao, L., Li, Y., & Xu, Y. (2021). *Cerebral Palsy*. 910–914. https://doi.org/10.1007/978-3-030-22009-9_1051

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods* (6th ed.). Sage Publications.

Zhang, Q., Choy, B. H., & Lee, M. Y. (2025). Teacher Noticing in Diverse Educational Contexts : Concepts , Research , and Future Pathways. *ECNU Review of Education*, *8*(3), 924–934. https://doi.org/10.1177/20965311251350160