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The Development of a Scaffolding-Based Instructional Model for Learners with Intellectual Disabilities

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ABSTRACT

Students with intellectual disabilities (also known as children with intellectual impairments) are individuals with below-average intelligence. Despite their cognitive limitations, these children still possess great potential to grow and excel in certain areas. This potential greatly depends on appropriate treatment that meets their specific needs. This study aims to design and develop a scaffolding-based learning model for students with intellectual disabilities at Sekolah Luar Biasa Negeri 1 Palopo (The Special Needs School 1 Palopo). This research employs Collaborative Action Research to identify students' Zone of Proximal Development, integrated into a Research and Development (4D) framework. The 4D stages (Define, Design, Develop, Disseminate) were conducted to construct the module and media. The subjects were 6 students with mild-to-moderate intellectual disabilities (Grades 2 to 5). The intervention consisted of two sessions (2x30 minutes) using customized number sticks and puzzles. Data collection techniques included observation, interviews, and tests, while data analysis was conducted using both quantitative and qualitative approaches. The results of the study indicate that the development process of the scaffolding-based learning model for students with intellectual disabilities at Sekolah Luar Biasa Negeri 1 Palopo consists of four stages: define, design, develop, and disseminate. Disseminate, generating learning tools in the form of teaching modules and instructional média, which have been developed and are considered suitable for use and considered to be valid.

Keywords
Intellectually Disability
Learning Model
Lifelong Learning Skills
Scaffolding

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Introduction

The education of learners with intellectual disabilities (ID) presents unique and multifaceted challenges that necessitate specialized instructional approaches grounded in evidence-based pedagogical frameworks [1]–[2]. Learners with ID often experience difficulties with abstract thinking, memory processing, problem-solving, and the critical generalization of learned skills across different contexts [3]–[4]. These cognitive deficits often co-occur with impairments in adaptive behavior, encompassing conceptual, social, and practical domains essential for independent living and learning [1], [3]. Collaboration among educators, clinicians, and families is vital to ensure that academic interventions are responsive to each child's cognitive profile, promoting not only academic growth but also independence and lifelong learning skills.

Building upon the outlined cognitive-adaptive challenges and the critical urgency of cross-stakeholder collaboration, the translation of evidence-based principles into classroom practice necessitates concrete and structured instructional strategies. Effective teaching strategies often involve breaking tasks into smaller, manageable steps, providing visual and verbal scaffolding, employing consistent repetition, and using concrete materials to bridge abstract concepts [1], [3].

To bridge the gap between evidence-based instructional principles and their responsive implementation for the cognitive-adaptive needs of students with intellectual disabilities, a framework that transcends basic teaching techniques is required. However, the application of evidence-based principles is frequently hampered by the limitations of conventional classroom methods when a truly responsive, graduated support framework, tailored to the unique learning profiles of students, is absent. These conventional methods often fail to provide the necessary support, thereby impeding academic progress and functional independence. Among the most promising and extensively tested approaches to address this challenge is Instructional Scaffolding, a systematic method of providing temporary and adaptive support that is gradually withdrawn as learners advance toward independent performance [5]–[6].

The theoretical foundations of instructional scaffolding are rooted in Lev Vygotsky's seminal sociocultural theory of learning, particularly his concept of the Zone of Proximal Development (ZPD) [7]. Vygotsky defined the ZPD as the critical space between what a learner

can accomplish independently and what they can achieve with targeted guidance from a "more knowledgeable other". While Vygotsky established the theory, the term "scaffolding" itself was later coined by Wood, Bruner, and Ross to describe the dynamic process of support that enables a novice to solve a problem beyond their unassisted efforts [8]. This theoretical framework is exceptionally relevant for learners with ID, as it emphasizes mediated, structured learning experiences to bridge the gap between current abilities and potential outcomes [9]–[10].

A substantial body of empirical research has consistently demonstrated the effectiveness of scaffolding-based models across multiple domains. In academic settings, systematic reviews have confirmed that scaffolding interventions significantly enhance mathematical skills, including problem-solving and foundational concepts, for students with ID [5], [11]. Similarly, in literacy, scaffolding techniques—such as the use of syllable cards, explicit modeling, and guided practice—have shown marked success in improving early reading abilities and comprehension [6], [12]–[13]. These findings are supported by broader meta-analyses indicating that explicit, systematic instruction, a core component of scaffolding, is critical for teaching reading to students with significant cognitive disabilities [14].

The benefits of scaffolding extend robustly into the development of functional life skills and cognitive strategies. Research highlights the efficacy of prompt scaffolding and specialized models (like the PCTL + PSA model) in teaching daily life skills, enhancing problem-solving abilities, and fostering greater independence in real-life contexts [15]–[16]. Furthermore, scaffolding has been proven effective in developing higher-order metacognitive strategies. By training students with mild ID in scaffolding techniques like "think-aloud" processes and verbalization, educators can improve their ability to self-regulate, plan, and generalize learned skills to new situations—a traditionally difficult hurdle for this population [4], [17].

Grounded in Vygotsky's concept of the Zone of Proximal Development (ZPD), *scaffolding* can be understood as a progressive instructional framework that bridges learners' initial competencies with their target competencies through structured, guided, and gradually withdrawn support. In this regard, [18] emphasizes—based on a systematic literature review—that scaffolded interventions in science education significantly enhance student performance by directing cognitive engagement and facilitating problem-solving processes. This argument is reinforced by [19], who assert that scaffolding naturally aligns with constructivist pedagogy by enabling learners to actively construct conceptual understanding, particularly in mathematics and geometry learning contexts. In the domain of early childhood education, [20] extends scaffolding theory to language learning by applying Vygotsky's ZPD to illustrate how guided interactions foster both linguistic and cognitive development. Her research highlights scaffolding as a temporary yet intentional pedagogical support that

gradually fades as learners achieve greater autonomy. Similarly, [21] underscores that scaffolding underpins contemporary pedagogical innovations by linking it to learner engagement and representational thinking within digital learning environments.

From a cognitive perspective, [22] connect scaffolding with the inquiry-based learning model, arguing that temporary instructional supports are essential for nurturing creative and analytical thinking, especially in chemistry education. In a similar vein, [23] note that scaffolding plays a crucial role in developing students' critical thinking skills, particularly when integrated into problem-based and probing–prompting pedagogical approaches. Collectively, these studies position scaffolding not merely as a form of instructional assistance but as a systematic learning-design framework that orchestrates learners' gradual transition from dependence to intellectual autonomy.

Effective scaffolding is characterized by several key mechanisms: individualization, explicit instruction, and the systematic fading of supports. Contemporary models often leverage technology and multimedia to provide flexible, multimodal support systems, aligning with the principles of Universal Design for Learning (UDL) to ensure accessibility [9], [24]. Technology-enhanced scaffolding, from computer-assisted instruction to digital literacy tools, can provide the consistent, adaptive, and patient support required to help learners build autonomy [10].

Based on this background, the development of a scaffolding-based learning model for students with intellectual disabilities is essential to ensure that teaching methods are aligned with their unique cognitive and adaptive needs. This research is significant because it can provide an empirical foundation for designing structured, gradual, and supportive learning processes that enhance students' understanding, independence, and self-confidence. Through the development and validation of an effective scaffolding model, educators can improve teaching practices in special education, making learning experiences more inclusive, personalized, and aligned with each learner's developmental pace.

Material and Methods

This study Research and Development (R&D) methods. The R&D method refers to the 4D model, which consists of four main stages: Define, Design, Develop, and Disseminate.

A. Define

An analysis is conducted regarding the needs, students, tasks, concepts, and learning objectives. This analysis is carried out through observations and interviews regarding the characteristics of children with intellectual disabilities to assess their conditions in learning or in receiving instructional materials.

B. Design

This stage involves determining the types of tests used to measure or assess the knowledge, attitudes, and skills of intellectual disability (*tunagrahita*) students in the form of tests and performance assessments. The evaluation of these three aspects employs assessment rubrics. On this stage, learning media are selected and developed in accordance with the learning objectives. A learning module is then prepared based on the Kurikulum Merdeka, which includes learning outcomes, instructional objectives, meaningful understanding, guiding questions, learning media, approaches and instructional models, learning activities, assessments, and is complemented by assessment rubrics and test items. The emerging ideas related to the scaffolding-based instructional model for children with intellectual disabilities are organized into a structured design.

C. Develop

At this stage, the learning tools are developed and integrated with the instructional model being designed. The scaffolding-based instructional model for *tunagrahita* children is validated by experts in the field. After validation, trials are conducted with *tunagrahita* students in collaboration with the senior teacher and assistant teacher.

D. Disseminate

The disseminate stage involves implementing the results from the previous three stages by packaging the validated learning tools, which can later be adopted by SLB Negeri 1 Palopo, especially for children with intellectual special needs.

The study involved six special needs students classified as *tunagrahita*. Data collection was conducted in collaboration with one senior teacher and one assistant teacher. Data were collected using observation, interviews, and tests. Both quantitative and qualitative data analysis techniques were used. The validation data of the developed learning tools and media were analyzed using Aiken's V. Intervention was delivered over two sessions, with each session lasting 2x30 minutes. The researcher, assisted by one senior teacher and one assistant teacher, facilitated the sessions. Evaluation was based on observational ratings during activities, focusing on students' ability to recognize numbers and match colors post-intervention.

E. Declarations/Ethical Considerations

Ethical Considerations: Before the study, ethical clearance and permission were obtained from the principal of SLB Negeri 1 Palopo. Informed consent was acquired from the parents or guardians of all participating students. Assent from the students was continuously monitored during the sessions. Participation was entirely voluntary, and all personal identities have been anonymized to ensure confidentiality.

Result and Discussion

The scaffolding-based instructional model was developed through the integration of direct learning syntax and a scaffolding model that emphasizes learner independence. In implementing this scaffolding-based model, the researcher integrated scaffolding methods grounded in Vygotsky's theory, which highlights the importance of teacher support throughout the learning process. This model is designed to assist *tunagrahita* students at SLB Negeri 1 Palopo who face challenges such as difficulty in maintaining focus, limited memory capacity, and emotional behavior that is hard to control.

The scaffolding-based instructional model consists of seven learning stages, including steps: (1) grouping the components to be mastered, (2) focusing on the provision of assistance, (3) communicating objectives and preparing students, (4) demonstrating knowledge and skills, (5) guiding practice, (6) checking student understanding through collaboration, and (7) providing opportunities for independent practice. This approach offers the necessary support at the initial stages, before gradually shifting responsibility to the students as they progress through the learning process.

The implementation of the scaffolding-based model creates meaningful learning experiences for *tunagrahita* students. Learners are given opportunities to interact with learning media customized to their learning styles, such as colored number sticks. Through these designed activities, students can explore information, practice skills, and collaborate with peers, thereby fostering a more inclusive and adaptive learning environment.

This instructional model was developed to address the challenges faced by *tunagrahita* students, whose Zone of Proximal Development (ZPD) indicates they require initial visual and kinesthetic prompts to recognize basic numerals and match colors, but can transition to independent task completion after guided practice in elementary school. Consequently, the scaffolding-based model can enhance learning effectiveness and assist students in achieving learning objectives, such as assembling and recognizing numbers 1 to 10, and matching numbers with corresponding colors. Through the development of this model, the researcher can contribute positively to the development of more innovative instructional models in line with the needs of learners with special needs. A profile of the scaffolding-based instructional model for *tunagrahita* children is presented in Table 1.

The scaffolding process applied a structured fading procedure. During Step 5 (Guiding practice), teachers provided full physical and verbal prompts to help students match puzzle pieces and colored sticks. As students showed comprehension in Step 6, the physical prompts were faded into indirect verbal cues (e.g., 'What color is this number?').

Finally, in Step 7 (Independent practice), all prompts were withdrawn, allowing students to manipulate the media independently while the teacher strictly observed.

Table 1. Syntax Matrix of the Scaffolding-Based Instructional Model for Children with Intellectual Disabilities

No.	Steps	Learners Activities	Teacher's Activities
1	Grouping the components to be mastered	Seating according to the predetermined arrangement by the teacher	Grouping or sequencing learning activities on number recognition using number sticks
2	Concentrating support provision	Observing and being motivated to participate in learning	Setting up the environment and instructional model for teaching number recognition (matching numbers with their corresponding colors)
3	Communicating objectives and preparing learners	Observing the teacher's explanation, responding to questions, and preparing to learn	Explaining the learning objectives for number recognition (matching numbers according to their colors)
4	Demonstrating knowledge and skills	Observing the teacher's explanation regarding the material and the practice conducted by the teacher about matching numbers and colors	Explaining the number recognition material and demonstrating how to match numbers with colors (by showing a video displaying numbers and colors)
5	Guiding practice	Practicing matching numbers and colors with teacher assistance	Facilitating practice by providing guidance, tools, and materials, as well as giving directions to learners on the steps to match numbers with colors
6	Checking learners' understanding through collaboration and providing feedback on their activities	Recognizing number symbols or numeral forms, and being able to identify the names of numbers and colors that have been matched	Asking questions about number symbols or the names of numbers and colors
7	Providing opportunities for independent practice to reinforce knowledge acquisition	Conducting independent matching exercises of numbers and colors with number sticks	Observing learners' activities

The instructional model for children with intellectual disabilities that has been developed was subsequently validated by several people who are considered experts (expert judgment). The experts assessed the teaching module and learning media based on format, language, content, and usefulness, as outlined in the learning tools validation instrument. The validation results of the learning tools are presented in Table 2.

Table 2. Validation Results of Learning Tools

Learning Tools	Vcount	Criteria
Teaching module	0,95	Valid
Learning Media	0,89	Valid

Based on the results of the development research, the validity value obtained for the teaching module was 0.95 with a valid category, while the number stick media achieved a

validity value of 0.89, also categorized as valid. These results indicate that both developed products meet the validity criteria in terms of content, presentation, language, and graphical aspects. The developed teaching module is considered highly appropriate for use as an instructional guide because it aligns with students' learning needs and instructional objectives. Meanwhile, the number stick media, as a concrete visual aid, was found to be valid and effective in helping students understand number concepts more easily and engagingly. Therefore, both the teaching module and the number stick media are feasible to proceed to the next stages of practicality and effectiveness testing in the classroom learning process.

Furthermore, research by [25] strongly affirms the importance of a highly valid teaching module as an essential and feasible instructional device within the framework of the Kurikulum Merdeka, which demands pedagogical innovation and promotes self-regulated learning among students. Complementing the module's structural validity, the role of concrete media is empirically justified by findings from [26], which established that the use of concrete objects significantly increases student engagement, facilitates the understanding of abstract concepts, and encourages higher learning motivation when compared to traditional methods.

The results of the trial using number-colored sticks media and video are presented in Table 3.

Table 3. Trial Results of the Scaffolding-Based Instructional Model for Children with Intellectual Disabilities

No.	Aspect	Results	Explanation
1	Knowledge	100%	Learners become accustomed to independently playing with number sticks as learning media
2	Attitude	79%	Learners are classified within the good category.
3	Skills	75%	Learners are classified within the good category.

The 100% achievement in knowledge demonstrates that the use of number sticks successfully fostered learners' *independent engagement with the medium*: they were able to recognize, understand, and manipulate number sticks without heavy reliance on teacher assistance. This finding aligns with recent empirical evidence showing that concrete and virtual manipulatives effectively bridge the concrete–representational–abstract (CRA/VRA) stages for students with special needs, including those with autism spectrum disorders and *mild intellectual disabilities*. Stepwise instruction following this sequence has been proven to enhance concept acquisition and maintain retention during the maintenance phase. Experimental findings on mathematical intelligence sticks (number sticks) also indicate a significant improvement in summation and number-recognition skills among students with intellectual disabilities after several structured sessions of guided practice [27]–[29].

The attitudinal aspect (79%), categorized as "good," reflects that learners exhibited a positive interest and engagement toward the *play-based learning* process using number sticks.

This outcome is typical, as affective dimensions are often influenced by the variety of activities, the element of play, and opportunities for collaboration. A systematic review published in a Sinta 2–indexed journal demonstrated that game-based learning consistently enhances both competence and learning motivation. This mechanism explains why activities involving number sticks tend to maintain positive learning attitudes and can be further strengthened through collaborative, challenging, and creative task design [30].

Meanwhile, the skills aspect (75%), also rated "good", indicates that procedural automatization, such as arranging sticks, counting, writing results, and transferring the learned concept to new problem types, was not yet fully stabilized among all learners. Literature on mathematics intervention for students with intellectual disabilities highlights that skill consolidation requires prompt-fading, maintenance drills, and generalization checks across contexts (from manipulatives to abstract symbols). Experimental studies following the VRA model report improvements in solving diverse problem types and sustained effects when instructional prompts are gradually faded. Similarly, research specifically addressing number sticks found substantial gains in performing addition within the range of 1–20 among children with mild intellectual disabilities after repeated practice sessions [27]–[28].

Vygotsky's scaffolding theory emphasizes the importance of providing appropriate support to help students achieve a better understanding [7]. The use of physical activities and direct actions as forms of scaffolding can assist students with intellectual disabilities in grasping the material more effectively. Teachers could act as "scaffolders" by guiding students through physical actions using relevant learning tools aligned with the concepts being taught.

This study presents novelty in the development of teaching materials specifically designed for children with intellectual disabilities based on scaffolding principles. Unlike previous research that primarily focused on developing learning media or modules, this study comprehensively designs teaching tools starting from planning, implementation, and assessment, customized to the characteristics and learning styles of children with intellectual disabilities, particularly at SLB Negeri 1 Palopo. The scaffolding strategy employed is also designed in stages according to the Zone of Proximal Development (ZPD), allowing support to be adjusted gradually in line with the increasing understanding of the students.

Furthermore, the learning tools in the form of modules and learning media become the development product that focuses on the cognitive and fine motor development of the students, including activities such as recognizing numbers 1 to 10, matching numbers with colors from videos, and distinguishing numbers with similar shapes and colors. The materials are developed contextually to be relevant to the students' daily lives. Validation of the learning tools was conducted by experts in the field, ensuring that the tools are not only theoretically feasible but also practical for field application. Therefore, this study contributes new insights

to special education by presenting a more structured, adaptive, and functional learning model for children with intellectual disabilities.

Conclusion

The development of a scaffolding-based learning model for children with intellectual disabilities, including learning tools such as instructional modules and learning media, utilizing the 4D model comprising the stages of define, design, develop, and disseminate, has met the criteria for validity and feasibility for use in learning. The presence of the scaffolding-based learning model in special schools (SLB) holds significant implications for children with intellectual disabilities, as it supports the gradual overcoming of their limitations, thereby encouraging the enhancement of the quality of education for these children. Moreover, it facilitates their inclusion within the broader education system and increases opportunities for children with intellectual disabilities to participate more actively in society. This study provides promising initial evidence of feasibility and content validity for a scaffolding-based learning model. However, the findings should be interpreted with caution. The primary limitations of this study are the small sample size (n=6) and the absence of a control group, which limits the generalizability of the effectiveness claims.

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