Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143

Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

Transforming Inclusive Mathematics Pedagogy: Reconstructing Adaptive Fraction Learning Design through Design Research for Students with Special Needs

Agustiany Dumeva Putri[1*], Riza Agustiani[2], Atika Zahra[3], Meily Agustin[4], Annisa Auliyah[5], Nela Salsabila[6], Muthi Hanifah[7]
Universitas Islam Negeri Raden Fatah, Palembang, Indonesia[1,2,3,4,5,6,7]
agustianydumevaputri_uin@radenfatah.ac.id, rizaagustiani_uin@radenfatah.ac.id,
atikazahra_uin@radenfatah.ac.id, 2210206003@radenfatah.ac.id,
annisaauliyah4@gmail.com, nelasalsabilaaa@icloud.com,
2220206023@radenfatah.ac.id

ABSTRAK

Pendidikan inklusif adalah sebuah janji peradaban yang menjamin hak dasar setiap individu untuk mengakses pengetahuan tanpa diskriminasi. Penelitian ini berfokus pada pengembangan desain pembelajaran matematika adaptif bagi siswa tunanetra dan tunarungu untuk memperkuat literasi numerasi pada materi pecahan. Masalah utama adalah rendahnya akses kognitif siswa ABK terhadap instruksi visual dan verbal. Penelitian ini dilakukan menggunakan rancangan penelitian *Design Research* tipe validation study. Kegiatan penelitian dilakukan dalam tiga tahap yakni tahap persiapan eksperimen, pelaksanaan ekperimen, dan analisis retrospektif. Teknik pengumpulan data yang digunakan adalah teknik observasi, wawancara, dan dokumentasi. Fokus pembahasan artikel ini merujuk pada bentuk media pembelajaran yang digunakan, *scaffolding* yang dibutuhkan dalam aktivitas pembelajaran, serta bentuk bantuan lain yang efektif membantu pemahaman siswa. Hasil penelitian menekankan efektivitas bantuan berupa penyediaan ilustrasi visualisasi dengan teknologi *Augmented Reality* (AR) untuk siswa tunarungu, serta *Audiobook* dan media taktil 3D untuk siswa tunanetra. Temuan utama menunjukkan bahwa intervensi melalui "Aktivitas 0" dan prinsip *Pacing Compensatory* sangat krusial untuk menjembatani hambatan sensorik.

Kata kunci : desain pembelajaran adaftif, pecahan, tunanetra, tunarungu

ABSTRACT

Inclusive education is a civilizational promise that guarantees the fundamental right of every individual to access knowledge without discrimination. This research focuses on developing an adaptive mathematics learning design for visually impaired and hearing-impaired students to strengthen numeracy literacy in fraction materials. The primary issue addressed is the low cognitive access of students with special needs toward visual and verbal instructions. This study was conducted using a design research method, specifically the validation study type. The research activities were carried out in three stages: the preparing for the experiment phase, the teaching experiment phase, and the retrospective analysis phase. Data collection techniques included observation, interviews, and documentation. The focus of this article refers to the forms of learning media used, the scaffolding required in learning activities, and other effective forms of assistance to aid student understanding. The results emphasize the effectiveness of assistance through the provision of visual illustrations using Augmented Reality (AR) technology for hearing-impaired

Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

students, as well as audiobooks and 3D tactile media for visually impaired students. The key findings indicate that interventions through "Activity 0" and the pacing compensatory principle are crucial in bridging sensory barriers.

Keywords : learning design, fraction, blind students, deaf students

INTRODUCTION

Inclusive education is a civilizational promise that guarantees the fundamental right of every individual to access knowledge without discrimination. In an ideal inclusive mathematics setting, learning environments should provide a space where every student's potential, whether expressed through spoken, written, tactile, or visual language, is granted full access to numeracy understanding. Consequently, an ideal mathematics class for blind and deaf students must be adaptive, multimodal, and specifically designed to accommodate unique sensory needs (Putri et al., 2025). Teachers are expected to design practical strategies that shift the focus from "disability" to "ability," providing unique modes of communication that reach both the "fingers" and the "hearts" of the students. Use the student's areas of strength to build confidence and provide context for difficult material (Kircher-Morris, 2021).

However, current factual evidence reveals a concerning gap in the implementation of these ideals. For blind students, structural barriers arise from the dominance of visual instructions, leading to the phenomenon of Symbolic Dual-Load, a condition where students must simultaneously struggle to decode complex Braille math symbols while constructing abstract mathematical concepts. Indicating that the inability to perceive symbols visually leads to deficiencies in conceptual development, as the brain is overly occupied with processing symbolic tactile input (Aktas & Argun, 2025). Meanwhile, deaf students, who are inherently "Visualitators," often face a lack of language understanding or linguistic-cognitive deficits when dealing with heavy mathematical terminology (Azzahra et al, 2025).

Previous research has attempted to address these challenges through the use of concrete manipulative media and Braille textbooks. Nevertheless, these solutions are often partial and remain unintegrated into a holistic learning trajectory, making numeracy efforts feel like "patching leaks" rather than building a sturdy ship (Wau et al., 2024). Some relevan research suggest some recommendations for learning instruction for students with special needs. The intervention is carried out through the application of differentiated instruction that integrates visual support, simplified instructions, and assessment modifications, while being supported by a support teacher who bridges communication through sign language and re-explanation to ensure deaf students' cognitive access to abstract mathematical concepts (Amiyani & Adhiwibowo, 2025). However, these interventions still require a new puzzle piece: the integration of advanced assistive technologies and systematic instructional designs to truly overcome real-time information processing barriers.

This research seeks to complete that puzzle by offering a reconstruction of adaptive learning designs that rely not only on physical objects but also on digital technology and pedagogical flexibility. Theoretically, the learning design in this study is supported by the Realistic Mathematics Education (RME) approach, which views mathematics as a human activity. Furthermore, the concept of a Hypothetical Learning Trajectory (HLT) is utilized as a dynamic navigation tool to predict the unique thinking

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

paths of students with special needs during the concept construction process. The primary novelty of this research lies in the comprehensive integration of specific assistance tools, including the utilization of various Artificial Intelligence (AI) platforms and the use of Augmented Reality (AR) for dynamic visualization tailored for deaf students. Moreover, this study introduces the concept of pre-learning scaffolding to strengthen the students' cognitive foundations, and the principle of "Compensatory Pacing" as a rhythmic adjustment to accommodate the sensory-symbolic double load of students with special needs (Azzahra et al, 2025). Through a design research approach of the validation study type, this article demonstrates how these innovative puzzle pieces can serve as a transformative solution for inclusive mathematics education in Indonesia (Amiyani & Adhiwibowo, 2025).

METHOD

This study employs a Validation Study design within the framework of Design Research (DR). While development-oriented design research centers on creating and evaluating interventions, a validation study focuses on establishing and refining relevant theoretical constructs (Akker et al., 2006). The design research consists of 3 steps: preparing for the experiment, the design experiment, and the retrospective analysis (Cobb & Gravemeijer, 2006). The iterative process ensures that the resulting theories (Local Instruction Theories or LIT) are empirically grounded and critically revised based on field findings (Akker et al., 2006; Cobb & Gravemeijer, 2006; Van Eerde, 2013). In the design process, based on current knowledge (K), researchers conduct thought experiments to design problems and activities (D), perform experiments (E) with these problems and activities, and reflect (R) on those trials. This cycle ultimately generates new knowledge (K).

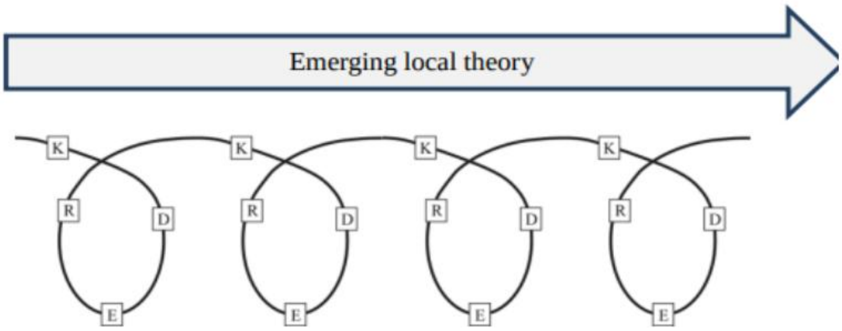

Figure 1. The design research iterative process
(Akker et al., 2006; Cobb & Gravemeijer, 2006; Van Eerde, 2013)

The research was conducted in a special education environment, focusing on students with visual and hearing impairments. The primary goal was to analyze results from the experimental phase to profile students' literacy and numeracy competencies. Participants were selected via purposive sampling from a special needs school to ensure the sample accurately represented the target disability groups. Participants of students with visual impairments or blind students are three students (HAS, RK, and RVA) from grade VIII for pilot experiment and two students (ASP and SL) from grade VII for teaching experiment. Participants of students with hearing impairments or deaf students are three students (MI, AJ, and R) with pre-lingual deafness from grade VII

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

for pilot experiment and six students (including MI, AJ, ZH, RD, DK, and SAGS) from grade VIII for teaching experiment.

To assess numeracy literacy, the study utilized a specialized test aligned with curriculum objectives and adapted for the unique needs of deaf and blind students. This *instrument* evaluated how students understand, apply, and communicate mathematical concepts within real-world scenarios. The following table presents examples of numeracy literacy assessment instruments used for blind and deaf students.

Table 1. Examples of numeracy literacy assessment instruments

No.	Learning Objective (LO)	Indicators	Question
1	Students can model real-world problems into fraction multiplication.	Able to use various numbers or symbols related to basic mathematics in solving daily life problems.	Mr. Budi owns a field with an area of 53 hectares. He plans to plant vegetables on 32 of the field. What is the area of the field that Mr. Budi will plant with vegetables?
2	Students can understand the concept of fraction multiplication.	Able to analyze information presented in various forms (graphs, tables, charts, diagrams, etc.).	A farmer owns 54 hectares of land. The land will be planted with several types of vegetables:- Eggplant: 32- Carrot: 31How many hectares of land are planted with carrots?
3	Students can solve fraction multiplication problems in more complex forms.	Interpreting analysis results to make predictions and take decisions.	Mr. Olid owns land with an area of 84 hectares. The land is used for gardening several types of vegetables:• 21 of the total land is for tomatoes.• 41 of the total land is for carrots.• The remaining land is for pumpkins.Mr. Olid plans to sell the garden with the largest area. Which garden will be sold?

In this study, the HLT, activity sheets, and assessment instruments were reviewed by a multidisciplinary team consisting of two mathematics education lecturers, one information systems lecturer, and one IT practitioner specializing in digital learning media. This collaborative approach ensures the instructional design is both theoretically grounded and practically applicable in real-world settings (Plomp & Nieveen, 2013). Furthermore, the involvement of both educators and IT specialists facilitates the seamless integration of digital tools within the mathematics curriculum (Schoenfeld, 2014).

Unlike traditional validation that seeks a single score, this expert review adopted a developmental approach focused on qualitative feedback and discussion to progressively enhance the learning design. The process did not merely aim for a "valid" category but served as a critical platform for refining the instruments through multiple iterations (Akker, 2006; McKenney & Reeves, 2019). This ensures that the final materials are robust and ready for implementation in the classroom.

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

Adopting a qualitative approach, the study aimed to provide a comprehensive, interpretative understanding of the specific educational context (Thanh & Thanh, 2015). Data were analyzed using the interactive model (Miles, Huberman, and Saldaña 2019), which involves three concurrent stages:

1. Data Reduction: Raw data—including test scores, student responses, and observation notes—were distilled into focused summaries. This stage categorized responses and highlighted emerging patterns in numeracy literacy.
2. Data Display: To facilitate a systematic comparison between the two disability groups, the reduced data were organized into matrices, tables, and narrative descriptions.
3. Conclusion Drawing and Verification: Final insights were derived by interpreting the organized data. Findings were cross-referenced against the original instructional goals to ensure that the conclusions regarding student competency profiles were robust and well-grounded.

RESULT AND DISCUSSION

This study utilizes a design research methodology to create specialized, adaptive instructional frameworks for blind students and deaf students. Focused on the concept of fractions, these tailored frameworks are defined as Local Instructional Theory (LIT). The core distinction between the two designs is the strategic use of each group's primary sensory modality, which serves as the foundation for the Hypothetical Learning Trajectory (HLT). The results are presented based on the two cycles of design research (Pilot and Teaching Experiments) for both blind and deaf student groups, followed by a synthetic discussion of the Local Instructional Theory (LIT) produced.

Initial Observations and Design Preparation

Initial observations at SLB-A PRPCN and SLB-B Negeri Pembina (Figures 1) revealed that students struggled significantly with distinguishing numerators and denominators. In the blind class, teachers previously used "nail boards" (*papan berpaku*) for Cartesian coordinates, providing the researchers with the idea to adapt this for fractional shading. In the deaf class, communication was a mix of SIBI (formal) and BISINDO (natural), leading to the decision to incorporate video sign language guides into the learning materials. The HLT was structured using the Iceberg Phenomenon. The "underwater" foundation utilized the ethnomathematical context, such as Kue Maksuba (Palembang traditional cake), which is physically layered, making it an ideal model for equivalent fractions and partitioning.

Figure 2. Students in initial observation

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

1. Learning Trajectory for Blind Students: Tactile Mastery and Symbolic Load

The design for blind students utilized the ethnomathematical context of Kue Maksuba and Kue Lapis, integrated with Audiobooks and 3D Tactual Blocks.

Pilot Experiment

This stage involved three students (HAS, RK, and RVA) from grade VIII at SLB-A PRPCN Palembang to test the initial HLT using the Maksuba Cake context. While students used tactual blocks to model fractions like 1/2 and 1/4, significant conceptual hurdles emerged. A primary misconception was the belief that a larger denominator represents a larger value, alongside the reversal of numerators and denominators (e.g., writing 4/6 as 6/4). Furthermore, the ‘Braille Nail Board’ proved counterproductive due to ambiguous tactile boundaries, prompting a redesign of the media based on Tactual Ergonomics.

Consequently, the evaluation of this pilot experiment necessitated a significant refinement of the initial HLT. These findings demonstrate that students require more explicit scaffolding to represent fractions tactually and a more robust procedural transition from identifying the LCM to executing arithmetic operations. Ultimately, the field results confirmed that the students’ initial conceptual fluency was overestimated; thus, the HLT was adjusted to provide the explicit guidance necessary to align with the students' actual cognitive trajectory.

Figure 2. Activity 1 (left) and Activity 3 (right) for pilot experiment of blind students

Teaching Experiment

This stage involved two students (ASP and SL) from grade VII at SLB-A PRPCN Palembang. In this instructional phase, students engaged with a multi-sensory learning environment by utilizing audiobooks to process word problems repeatedly while simultaneously manipulating Braille-marked fraction blocks to solve addition and multiplication. This active manipulation allowed for a concrete exploration of mathematical logic, yet it simultaneously exposed the "Symbolic Dual-Load" phenomenon; for instance, SL, a transfer student, found it nearly impossible to decode Braille symbols while concurrently building the abstract concept of fractions. The effectiveness of the physical activity was further evidenced by ASP, whose hands-on partitioning of blocks into 1/2 and 1/4 led to the accurate tactile observation that the 1/2 piece was "wider and heavier." However, the activity also highlighted a significant "Oral-Written Gap," as ASP could fluently solve complex equations like 1/6 + 1/3 = 1/2 through oral reasoning but suffered from cognitive fatigue when attempting to transcribe these results into Braille. Ultimately, the exercise demonstrated that while the physical activity successfully fostered conceptual understanding, the transition to formal symbolic expression remained a substantial cognitive barrier. Despite these specific cognitive challenges, this finding confirms the initial HLT assumption that the designed learning sequence is effectively aligned with the Actual Learning Trajectory

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

(ALT). The high degree of consistency between the planned activities and student responses demonstrates that the HLT is pedagogically sound and ready to be elevated into a Local Instructional Theory (LIT).

Figure 3. Activity 1 (left) and Activity 3 (right) for teaching experiment of blind students

2. Learning Trajectory for Deaf Students: Visualitators and AR Scaffolding

The design for deaf students focused on Augmented Reality (AR), origami, and sign language video integration.

Pilot Experiment

This stage involved three students (MI, AJ, and R) with pre-lingual deafness from grade VII at SLB-B Negeri Pembina. In this phase of the experiment, students utilized Assemblr Studio to scan QR codes, which activated 3D visualizations of classroom objects being partitioned to provide a vivid, digital representation of fractional concepts. While the augmented reality tools enhanced visual engagement, the activity uncovered significant linguistic hurdles as students struggled to parse long, narrative word problems, alongside physical challenges in using rulers for precise measurement due to fine motor skill limitations. To address these barriers, the researchers implemented a strategic revision by replacing manual measurement with Origami Folding to simplify tactile tasks and introducing Activity 0, a dedicated context-orientation phase designed to build the necessary linguistic foundations before transitioning into mathematical content. This finding refines the initial HLT assumption that students can independently navigate mathematical tasks through visual media alone. The retrospective analysis reveals that students require explicit guidance to bridge the gap between visual perception and instructional intent, as well as more ergonomic physical tasks, such as folding rather than measuring, to accommodate fine motor limitations during fraction partitioning.

Teaching Experiment

The design was implemented with six students (including MI, AJ, ZH, RD, DK, and SAGS) at SLB-B Negeri Pembina. To visualize multiplication, students integrated AR scanning with origami folding and the Bar Shading method, an approach that directly confronted the "Whole Number Bias" prevalent among participants. This bias was notably observed in students SAGS and MI, who instinctively believed that the product of 1/2 x 1/3 should be larger than its factors; however, they corrected this misconception only after the Bar Shading documentation visually demonstrated a smaller intersection area of 1/6. Further student response data highlighted the effectiveness of these tools. Student ZH, who previously struggled with equivalent fractions, used a dynamic AR model to observe two 1/4 segments merging into 1/2 and correctly identified them as being "the same size," while RD successfully utilized paper folding to divide a whole into 12 segments to solve 1/3 + 1/4 = 7/12. Despite

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

these successes, the research identified a strong visual dependency, revealing that while students performed excellently with AR support, their capacity for vertical mathematization and abstract procedural application significantly declined once the visual scaffolding was removed. The retrospective analysis reveals that while the HLT successfully bridged the gap in multiplication, a conceptual interference occurred during the transition to addition. Students frequently misapplied multiplication logic to addition problems with different denominators, indicating that further scaffolding is required to help students differentiate between these two distinct operations.

Pillars of the Local Instructional Theory (LIT)

The retrospective analysis across all cycles validated three essential assistance pillars that complete the puzzle of adaptive math education.

Pillar 1: The Concept of "Activity 0" (Foundational Scaffolding)

The research found that jumping directly to mathematical partitioning was too rapid for ABK students. Activity 0 was implemented as a mandatory orientation phase. For blind students, it involved tactile mapping of the workspace. For deaf students, it used sign-language avatars via Kreado.ai to explain the "Story" behind the math before any calculation occurred. It provides the necessary scaffolding for students to attain higher learning targets in Activity 1 and subsequent activities (McKenney & Reeves, 2019). In accordance with the philosophy of design research, which states, 'If you want to understand something, you must change it, and if you want to change something, you must understand it' (Bakker, 2018). The modification of the HLT (the addition of Activity 0) serves as a means to better understand the students' learning process.

Pillar 2: The principle of "Compensatory Pacing"

The Actual Learning Trajectory (ALT) was consistently 40-50% slower than standard classroom expectations. This is not a deficit in intelligence but a requirement for processing dual sensory inputs (e.g., listening to an audiobook while feeling a block). "Compensatory Pacing" advocates for curriculum flexibility, prioritizing depth over speed.

Pillar 3: AI-Assisted Media Personalization

The integration of various AI platforms addressed the lack of adaptive materials. Student RD's responses showed that AI-generated comics significantly increased reading interest compared to standard textbooks. Blind students benefit significantly from the use of audiobooks paired with Braille, which allows for repeated oral comprehension of questions (Marcone & Penteado, 2013). Meanwhile, deaf students require unique visual and concrete adaptations (Marcelino et al., 2019; Amiyani & Adhiwibowo, 2025). Both of these needs are more easily facilitated and accessed through technology such as AI and AR, whether utilized by teachers to develop instructional materials or by students during the learning process (Agustiani et al., 2024; Putri et al., 2025).

The synthesis reveals that while technology (AR and AI) and tactile media provide the "how," the HLT provides the "way". The Iceberg Phenomenon proved crucial; by strengthening the "underwater" foundations (informal knowledge) through Activity 0, students were better prepared for formal symbols. However, the "Oral-Written Gap" and "Visual Dependency" highlight that assessment must also be adaptive, suggesting a move toward Multi-Modality Assessments.

Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

CONCLUSION

This research successfully developed and validated an adaptive learning design for fraction multiplication and addition specifically tailored for students with visual and hearing impairments, demonstrating that the implemented Hypothetical Learning Trajectory (HLT) is pedagogically sound and aligns effectively with the Actual Learning Trajectory (ALT) to justify its elevation to a Local Instructional Theory (LIT). The findings conclude that transforming inclusive pedagogy requires a fundamental reconstruction of the learning sequence through three critical pillars: the implementation of 'Activity 0' to bridge the literacy-context gap and clarify instructional intent, the adoption of 'Compensatory Pacing' to accommodate a 40-50% slower cognitive processing rhythm, and the integration of AI-assisted media personalization, including AR, AI-generated comics, and audiobooks, to convert abstract mathematical symbols into concrete, multi-sensory experiences. Ultimately, by strengthening these informal 'underwater' foundations, this adaptive design enables students with special needs to overcome significant sensory and cognitive barriers to achieve formal mathematical proficiency.

However, the study also identifies limitations concerning the researchers' direct interaction with students who are deaf or blind, which means it may not yet be fully sensitive to the entire of difficulties students encounter in the field. Nonetheless, this study offers significant insights for educators to increase their pedagogical sensitivity and gain a deeper understanding of the learning characteristics of students with special needs.

It is recommended that educators implement multi-modal assessments to avoid transcription bias and enhance their capacity to master adaptive strategies based on assistive technology. Inclusive mathematics education is no longer about standardizing all students; instead, it is about providing different 'ladders' for each student to reach the same 'peak' of understanding. By continuously refining disability-sensitive Local Instructional Theory, Indonesia can fulfill the civilizational promise of education that is truly free from discrimination.

REFFERENCES

Agustiani, R., Zahra, A., Putri, A. D., Hadi, M., Marwan, A., Solehah, A. M., ... & Sopani, A. (2024). Students' numeracy literacy using artificial intelligence (AI)-based worksheets. *Indiktika: Jurnal Inovasi Pendidikan Matematika*, 7(1), 173–181.

Akker, J. van den, Gravemeijer, K., McKenney, S., & Nieveen, N. (2006). Introducing educational design research. In *Educational design research*. Routledge. https://doi.org/10.4324/9780203088364

Aktas, F. N., & Argun, Z. (2025). Students with visual impairments' comprehension of visual and algebraic representations, relations and correspondence. *Education Sciences*, *15*(8), Article 1083.

Amiyani, R., & Adhiwibowo, B. (2025). Mathematics learning for deaf students: A case study in an inclusive classroom. *Tematik: Jurnal Konten Pendidikan*

Azzahra, A., Mawarsari, V. D., & Suprayitno, I. J. (2025). Inovasi pendidikan inklusif: Analisis kebutuhan media pembelajaran interaktif berbasis teknologi untuk siswa tunarungu. *Jurnal Genta Mulia*, *16*(1), 75–87.

Bakker, A. (2018). *Design research in education*. Routledge.

Indiktika : Jurnal Inovasi Pendidikan Matematika
P-ISSN 2655-2752, E-ISSN 2655-2345
Desember 2025, Volume 8 No. 1 Hal. 288 - 297
DOI : 10.31851/indiktika.v8i1.21143
Submitted : 21 Oktober 2025
Accepted : 23 Desember 2025
Published : 27 Desember 2025

https://doi.org/10.4324/9780203701010

Cobb, P., & Gravemeijer, K. (2006). Design research from a learning design perspective. In Educational design research (pp. 29–63). Routledge.

Kircher-Morris, E. (2021). *Teaching twice-exceptional learners in today's classroom*. Free Spirit Publishing.

Marcelino, L., Sousa, C., & Costa, C. (2019). Cognitive foundations of mathematics learning in deaf students: A systematic literature review. *EDULEARN19 Proceedings*, 5914–5923.

Marcone, R., & Penteado, M. G. (2013). Teaching mathematics for blind students: A challenge at the university. *International Journal for Research in Mathematics Education*, *3*(1), 23–35.

McKenney, S., & Reeves, T. C. (2019). *Conducting educational design research* (2nd ed.). Routledge. https://doi.org/10.4324/9781315105642

Miles, M. B., Huberman, A. M., & Saldaña, J. (2019). *Qualitative data analysis: A methods sourcebook*. SAGE Publications.

Plomp, T., & Nieveen, N. (Eds.). (2013). Educational design research: Part A - An introduction. SLO. https://doi.org/10.1007/978-94-6300-275-6

Putri, A. D., Agustiani, R., & Zahra, A. (2025a). Designing learning instructional theory topics special lines triangle with augmented reality: A design research. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *16*(1), 260–274.

Putri, A. D., Agustiani, R., & Zahra, A. (2025b). *Melihat dengan jari, mendengar dengan hati: Desain pembelajaran pecahan adaptif untuk siswa tunanetra dan tunarungu*. Bening Media Publishing.

Schoenfeld, A. H. (2014). What makes for powerful classrooms, and how can we support teachers in creating them? Educational Researcher, 43(8), 404-412. https://doi.org/10.3102/0013189X14554450

Thanh, N. C., & Thanh, T. T. (2015). The interconnection between interpretivist paradigm and qualitative methods in education. *American Journal of Educational Science*, *1*(2), 24–27.

Van Eerde, H. A. A. (2013). Design research: Looking into the heart of mathematics education. In Proceedings van de 1st South-East Asian Design Research conference, 2-23 April 2013, UNSRI, Palembang (pp. 1-11).

Wau, M. P., Kale, D. E., Tuna, M., Meo, M., Nono, U., & Ito, Y. K. (2024). Penggunaan media braille untuk anak tunanetra di SLBN Bajawa. *Jurnal Pendidikan Inklusi Citra Bakti*, *2*(2), 166–173.