DIDAKTIKA TAUHIDI
JURNAL PENDIDIKAN GURU SEKOLAH DASAR
p-ISSN 2442-4544 | e-ISSN 2550-0252
ojs.unida.ac.id/jtdik

# Enhancing Elementary School Teachers' Competence through Adaptive Mathematics Materials for Children with Down Syndrome

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Volume 13 Nomor 1
April 2026: 91-100
DOI: 10.30997/dt.v13i1.23525

Article History
*Submission: 01-12-2025*
*Revised: 05-03-2026*
*Accepted: 10-04-2026*
*Published: 30-04-2026*

Keywords:
Teacher Competence, Adaptive Mathematics Materials, Down Syndrome, Inclusive Education, Elementary School.

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**ABSTRACT**

This study aims to strengthen elementary school teachers' competence through the use of adaptive mathematics materials for children with Down syndrome. The research employed a Research and Development (R&D) approach using the ADDIE model, which includes analysis, design, development, implementation, and evaluation stages. The development process was based on a needs analysis conducted in two special education schools, namely SLB BC Mahardika Depok and SLB BC Abdi Pratama Munjul. The adaptive mathematics materials focus on number recognition (1–20), addition and subtraction (1–9), and time concepts, presented through illustrated and colorful learning materials tailored to the characteristics of children with Down syndrome. Product validation was carried out by material experts and design experts using questionnaire instruments. The validation results showed high feasibility levels, with material expert scores of 97.5% and 91.25%, and a design expert score of 93.33%, all categorized as good and appropriate. These findings indicate that the developed adaptive mathematics materials are feasible to support teachers in delivering inclusive mathematics instruction and enhancing their professional competence in teaching children with Down syndrome.

## 1. Introduction

Elementary education plays a fundamental role in shaping students' cognitive, social, and emotional development. At this level, teachers are required to possess not only strong pedagogical competence but also the ability to adapt learning processes to the diverse needs of students, including children with special needs. Inclusive education has become a global commitment to ensure that all children, regardless of their physical, intellectual, or developmental conditions, have equal access to quality education. One group of learners who require special attention in elementary mathematics learning is children with Down syndrome(Erdoğan & Kalkan, 2025).

Children with Down syndrome generally experience limitations in attention span, memory retention, and abstract thinking, which often affect their ability to

understand mathematical concepts such as numbers, arithmetic operations, and time. Mathematics, as a subject that relies heavily on logical reasoning and symbol recognition, is frequently perceived as difficult by these students. Therefore, teachers need adaptive learning materials that are concrete, visual(Bastian et al., 2025), and contextual to support students' understanding and engagement. Without appropriate instructional support, mathematics learning may become ineffective and hinder students' academic development.

In practice, many elementary school teachers still face challenges in designing and using mathematics materials that align with the characteristics and learning needs of children with Down syndrome(Sağıroğlu et al., 2025). Learning materials are often limited to general textbooks that are not specifically designed for students with special needs. This condition indicates the need to strengthen teachers' professional competence, particularly in selecting, adapting, and utilizing instructional materials that support inclusive mathematics learning. Adaptive mathematics materials, especially those presented in illustrated and colorful formats, can serve as effective tools to bridge abstract mathematical concepts with students' real-life experiences.

Several previous studies have emphasized the importance of adaptive learning materials and teacher competence in inclusive education(Fadillah, 2024) settings. Research has shown that the use of visual-based and contextually relevant materials can improve learning motivation and comprehension among children with intellectual disabilities. Other studies highlight that teachers' competence in inclusive(Izzati et al., 2025) classrooms significantly influences the success of learning implementation. However, research that specifically focuses on the development and validation of adaptive mathematics materials as a means of strengthening elementary school teachers' competence in teaching children with Down syndrome remains limited.

The novelty of this study lies in its focus on adaptive mathematics materials as a practical instrument to enhance teachers' competence in inclusive elementary classrooms. Unlike previous studies that primarily discuss inclusive education conceptually or focus on students' learning outcomes alone, this research presents a concrete learning product that can be directly used by teachers. Therefore, this study aims to analyze the feasibility and effectiveness of adaptive mathematics materials in supporting elementary school teachers' competence in teaching mathematics to children with Down syndrome.

## 2. Methods

### 2.1 Research Design

This study employed a Research and Development (R&D) method using a mixed-method approach with a sequential exploratory design. The development process aimed to produce adaptive mathematics materials that can support elementary school teachers' competence in teaching children with Down syndrome. The development framework followed the ADDIE model, consisting of five stages: Analysis, Design, Development, Implementation, and Evaluation.

### 2.2 Research Site and Participants

The study was conducted at SLB BC Abdi Pratama Munjul, an inclusive special education school. Participants involved in this research consisted of teachers and students with Down syndrome at the elementary level, as well as experts in mathematics education and instructional design. Teachers participated as users of the adaptive mathematics materials, while students were involved in limited product trials to examine usability and suitability.

### 2.3 Product Development Procedure

At the analysis stage, a needs assessment was carried out through classroom observations and interviews to identify students' characteristics, curriculum requirements(Ginting et al., 2025), and teachers' instructional needs.

The design stage involved preparing a content outline, learning objectives, material maps, and visual layouts for the adaptive mathematics materials. During the development stage, the materials were produced in the form of illustrated and colorful learning books covering number recognition (1–20), addition and subtraction (1–9), and time concepts.

The implementation stage included limited trials and expert validation involving material experts and design experts. Finally, the evaluation stage was conducted to revise the product based on expert feedback and user responses to ensure feasibility and practicality.

### 2.4 Data Collection Techniques

Data were collected using questionnaires, interviews, and documentation. Questionnaires were administered to experts and teachers to assess the feasibility and practicality of the adaptive mathematics materials. Interviews were conducted to obtain qualitative feedback regarding the strengths and weaknesses of the product.

### 2.5 Instrument Validity and Reliability

Instrument validity was established through expert judgment, involving specialists in elementary education, special education(Surya Sari Faradiba et al., 2024), and instructional design. The experts evaluated the instruments based on relevance, clarity, and appropriateness. Revisions were made according to expert suggestions to ensure content validity and consistency.

### 2.6 Data Analysis

Data analysis was conducted using descriptive quantitative and qualitative techniques. Quantitative data from questionnaires were analyzed using a Likert scale and calculated using the Weighted Mean Score (WMS) method to determine the level of product practicality. Qualitative data from interviews and open-ended responses were analyzed descriptively to support quantitative findings. The results were then interpreted based on predetermined practicality criteria to conclude the feasibility of the developed adaptive mathematics materials.

## 3. Results & Discussion

### 3.1 Results

This study aimed to examine the practicality of an adaptive mathematics learning module developed for elementary school students with Down Syndrome. The development of this instructional product was grounded in the recognition that students with Down Syndrome possess unique cognitive, linguistic, and attentional characteristics that require differentiated instructional approaches, particularly in learning mathematics, which is often perceived as abstract and cognitively demanding. Therefore, the product trial focused on evaluating the extent to which the developed materials could be implemented easily, understood clearly, and utilized effectively by teachers and learners in real classroom settings.

The product implementation was conducted on a limited scale in two special education institutions, namely SLB BC Mahardika Depok and SLB BC Abdi Pratama Munjul, which serve students with various intellectual and developmental disabilities(Azme et al., 2025), including Down Syndrome. The trial involved mathematics teachers as primary users of the product, supported by expert validators who assessed the feasibility and practicality of the materials from both pedagogical and design perspectives. The results are presented in two main sections: (1) practicality based on expert validation, and (2) practicality based on classroom implementation.

#### 3.1.1 Practicality of the Adaptive Mathematics Learning Materials Based on Expert Validation

The practicality assessment through expert validation was conducted to ensure that the adaptive mathematics learning materials met essential pedagogical, cognitive, and design standards before being applied more broadly in classroom contexts. Three experts were involved in this validation process: two subject-matter experts in mathematics education for students with special needs and one instructional design expert with experience in developing visual-based learning materials for children with intellectual disabilities.

The evaluation instrument covered several critical aspects, including content suitability, language clarity, instructional presentation, and visual design quality. These dimensions were selected based on the assumption that learning materials for students with Down Syndrome must prioritize conceptual simplicity, clarity of instruction, and strong visual support to accommodate limitations in working memory, abstract reasoning, and sustained attention.

The first material expert validation yielded a practicality score of 97.5%, categorizing the learning materials as *very appropriate*. This result indicates that the mathematical content was highly aligned with the learning needs and cognitive profiles of students with Down Syndrome. The expert highlighted that the selection of topics—number recognition from 1 to 20, basic addition and subtraction from 1 to

9, and introductory time concepts—was appropriate for the developmental stage of upper elementary students with intellectual disabilities. The content progression from simple to more complex concepts was also deemed systematic(Marhamah et al., 2025) and supportive of gradual learning.

The second material expert provided a practicality score of 91.25%, which also fell within the *appropriate* category. Although slightly lower than the first expert's score, this assessment still reflects strong alignment between the materials and instructional objectives. The expert noted that the use of repetition, step-by-step exercises, and concrete examples contributed positively to students' understanding. However, the expert also suggested that some sections contained an excessive number of exercises for a single learning session, which could potentially overwhelm students with limited concentration spans.

In addition to content validation, the instructional design expert evaluated the visual and structural aspects of the learning materials. The validation result from the design expert produced a score of 93.33%, categorized as *appropriate*. This assessment confirmed that the layout, color selection, font size, and illustration usage were suitable to support students' visual perception and memory retention. The use of bright yet non-distracting colors, large fonts, and familiar images was considered effective in maintaining students' attention and reducing cognitive load.

Overall, the expert validation results indicate that the adaptive mathematics learning materials possess a high level of practicality and feasibility. The strong validation scores across content and design dimensions suggest that the product is ready for classroom use with minor revisions, particularly related to content density and spacing between visual elements.

### 3.1.2 Practicality of the Learning Materials in Classroom Implementation

Following expert validation, the adaptive mathematics learning materials were implemented on a limited basis in classroom settings to assess their practical usability from the perspective of teachers and students. Classroom implementation focused on observing how easily teachers could use the materials, how students responded to the instructional design, and whether the materials effectively supported the learning process.

Teachers reported that the adaptive mathematics module was easy to use and teacher-friendly, particularly because it provided clear instructions, structured learning sequences, and ready-to-use exercises. The module reduced teachers' preparation time, as the materials were already aligned with students' cognitive levels and learning objectives. Teachers also noted that the systematic organization of the content allowed them to adjust pacing based on students' responses and learning speed.

One of the most prominent findings during classroom implementation was the positive impact of the illustrated and colorful presentation on student engagement. Students demonstrated increased attention and participation compared to previous lessons that relied on text-heavy or abstract instructional materials. The presence of visual representations helped students focus on tasks for longer periods and facilitated comprehension of numerical concepts.

The use of contextual images drawn from students' daily experiences, such as objects commonly found at home or school, played a significant role in bridging the gap between abstract mathematical concepts and concrete understanding. For example, number recognition activities were linked to familiar items, such as fruits, toys, or classroom objects, enabling students to associate numbers with tangible quantities. Similarly, time concepts were introduced through daily routines, such as morning, afternoon, and evening activities, making abstract temporal concepts more accessible.

Despite the overall positive evaluation, classroom implementation also revealed areas for improvement. Teachers suggested reducing the amount of content presented in a single session, as students with Down Syndrome(Mardhia, 2025)often require more time to process information and benefit from repeated exposure to smaller learning units. Increasing the spacing between illustrations was also recommended to prevent visual overload and allow students to focus on one concept at a time.

Additionally, teachers proposed incorporating learning activities linked to songs, rhythms, or simple movements, as students with Down Syndrome tend to respond positively to auditory and kinesthetic stimuli. These suggestions highlight the importance of multimodal learning approaches that combine visual, auditory, and motor elements to maximize learning effectiveness.

Overall, classroom implementation findings indicate that the adaptive mathematics learning materials are practical, feasible, and supportive of instructional delivery in special education settings. The materials effectively enhance student engagement and understanding while providing teachers with a structured and accessible instructional resource.

### 3.2 Discussion

The findings of this study demonstrate that the developed adaptive mathematics learning materials achieved a high level of practicality, as evidenced by expert validation scores exceeding 90% and positive feedback from classroom implementation. These results suggest that the product is not only conceptually valid but also operationally feasible for use in real educational contexts, particularly in special education schools serving students with Down Syndrome.

From the perspective of educational design research, practicality is a critical quality criterion alongside validity and effectiveness (Nieveen, 1999; Plomp & Nieveen, 2013). A practical instructional product is one that can be used easily by teachers, understood clearly by learners, and implemented within existing classroom constraints. The high practicality scores obtained in this study indicate that the developed materials meet these criteria, reinforcing the importance of user-centered design in educational product development.

The strong alignment between the learning materials and students' cognitive characteristics can be attributed to several key design principles. First, the use of visual illustrations plays a central role in supporting cognitive processing for students with intellectual disabilities. Research has consistently shown that visual supports enhance comprehension, memory retention, and task engagement among learners with Down Syndrome, who often experience difficulties with abstract reasoning and verbal processing. By integrating images that represent real-life objects and situations, the

learning materials reduce abstraction and make mathematical concepts more concrete and meaningful.

Second, the use of simple and clear language contributes significantly to the practicality of the materials. Students with Down Syndrome often exhibit delayed language development and limited vocabulary, making complex sentence structures and technical terminology difficult to understand(Samaniego López et al., 2025). The learning materials in this study employed short sentences, familiar words, and explicit instructions, which facilitated comprehension and minimized confusion. This approach aligns with inclusive education principles that emphasize accessibility(Liu & Potmesil, 2025) and clarity in instructional communication.

Third, the gradual progression of content from simple to more complex concepts reflects an understanding of students' learning needs. Beginning with basic number recognition before introducing addition, subtraction, and time concepts allows students to build foundational skills and confidence. This sequencing strategy supports scaffolding, enabling learners to progress at their own pace while reinforcing previously learned concepts.

The classroom implementation findings further highlight the importance of contextual and experiential learning in mathematics education for students with Down Syndrome. By linking mathematical concepts to daily life experiences, the materials help students perceive mathematics as relevant and applicable, rather than abstract and intimidating. This contextualization not only enhances understanding but also increases motivation and engagement, which are critical factors in successful learning outcomes.

However, the study also underscores the need to carefully manage content density. While comprehensive coverage of material is important, excessive content in a single session may overwhelm students with limited attention spans and working memory capacities. This finding is consistent with previous research suggesting that instructional materials for students with intellectual disabilities should prioritize depth over breadth and emphasize repetition and reinforcement rather than extensive content coverage.

The suggestions to incorporate songs, rhythms, and movement-based activities further emphasize the value of multimodal learning approaches. Students with Down Syndrome often respond positively to auditory and kinesthetic stimuli, which can enhance memory retention and engagement. Integrating these elements into future iterations of the learning materials could further improve their effectiveness and inclusivity.

From a theoretical standpoint, this study contributes to the literature on inclusive(Faragher et al., 2016) and special education by providing empirical evidence that adaptive learning materials can effectively support mathematics instruction when designed based on learner characteristics and validated through expert review. The study reinforces the notion that instructional design for students with special needs must be grounded in an understanding of cognitive diversity and informed by continuous feedback from educators and experts.

Practically, the developed adaptive mathematics module serves as a valuable supplementary teaching resource for teachers in special education settings. It provides structured guidance, reduces instructional preparation burdens, and enhances

student engagement through visual and contextual supports. Moreover, the module's design principles can be adapted for use in inclusive classrooms, where students with and without disabilities learn together.

Despite its strengths, this study has limitations that should be acknowledged. The product trial was conducted on a limited scale in two schools, which restricts the generalizability of the findings. Additionally, the study focused primarily on practicality and did not examine long-term learning outcomes or behavioral changes. Future research should involve larger samples, diverse school contexts, and longitudinal designs to evaluate the effectiveness and impact of the learning materials on students' mathematical achievement and independence(Schnepel et al., 2024).

In conclusion, the adaptive mathematics learning materials developed in this study are practical, appropriate, and supportive of mathematics learning for elementary school students with Down Syndrome. The findings highlight the importance of visual design, contextual learning, and user-centered development in creating effective instructional resources for students with special needs(Jung, 2025). Continued refinement and broader implementation of the materials have the potential to contribute significantly to inclusive and equitable mathematics education.

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## 4. Conclusion

Based on the results of the limited-scale implementation, the developed learning model and adaptive mathematics teaching materials demonstrated a high level of practicality. This is indicated by the Weighted Mean Score (WMS) of 4.31, which falls into the *very feasible* category. These findings suggest that the developed model and teaching materials are appropriate and practical for use in elementary education settings, particularly in supporting inclusive and child-friendly learning environments.

Nevertheless, this study has limitations in measuring long-term effectiveness. Outcomes such as sustained behavioral changes, reduction in incidents of school violence, or long-term improvement in students' mathematical competence could not be examined due to the limited duration and scale of field testing. Therefore, further studies involving broader implementation and longitudinal evaluation are recommended to assess the long-term impact of the developed model.

Despite these limitations, this study provides a strategic contribution both practically and theoretically. Practically, the developed adaptive mathematics teaching materials can serve as supplementary learning resources for teachers in special education schools, particularly for students with Down Syndrome. Theoretically, this study enriches the body of literature on school capacity building and inclusive education by integrating pedagogical, instructional design, and child-friendly school climate perspectives within a single development framework.

## Acknowledgments

The author would like to express sincere and profound gratitude to Huri Suhendri, M.Pd., as Supervisor I, and Yogi Wiratomo, M.Pd., as Supervisor II, for their invaluable guidance, direction, and constructive scholarly input throughout the planning, implementation, and preparation of this research manuscript. Their

continuous support and academic insights have greatly contributed to the completion of this study.

The author also extends heartfelt appreciation to Prof. Dr. Supardi U., S. and Tatan Zenal Mutakin, M.Pd., as examiners, for their valuable critiques, suggestions, and academic evaluations, which significantly enhanced the quality of both the research and this article.

Further gratitude is addressed to Mr. Muhamad Ajhar, Principal of SLB BC Abdi Pratama Munjul, and Drs. H. Mulyadi, Principal of SLB C Mahardika Depok, for granting permission and providing full support during the research implementation. Special appreciation is also conveyed to the teachers and students of both schools for their cooperation and active participation during the data collection process and the teaching material development trials.

May all assistance and contributions provided be rewarded and bring meaningful benefits to the advancement of special education and inclusive education in Indonesia.

**References**

Azme, A. S. M., Rosli, R., Khairuddin, K. F., & Razak, F. A. (2025). Teachers' Readiness in Teaching Mathematics to Special Educational Needs Students with Learning Disabilities. *International Journal of Research and Innovation in Social Science*, 6831–6839. https://doi.org/10.47772/IJRISS.2025.908000561

Bastian, A., König, J., Ross, N., Klee-Schramm, I., Sommer, D., Strauß, S., Rott, B., & Kaiser, G. (2025). Teacher competence in inclusive mathematics education: examining the effects of an innovative professional development program on teacher noticing. *ZDM – Mathematics Education*. https://doi.org/10.1007/s11858-025-01731-x

Erdoğan, F., & Kalkan, S. (2025). Inclusive Mathematics Education and Down Syndrome: Cognitive Foundations and Evidence-Based Teaching Recommendations. *Eğitimde Kuram ve Uygulama*, *21*(1), 87–100. https://doi.org/10.17244/eku.1686308

Fadillah, L. N. R. C. J. P. F. W. (2024). Implementation of Inclusive Education for Children with Special Needs in Elementary Schools. *BASICA Journal of Primary Education*, *Vol. 4 No.*(Vol. 4 No. 2 (2024)). https://doi.org/https://doi.org/10.37680/basica.v4i2.5761

Faragher, R., Hill, J., & Clarke, B. (2016). Inclusive Practices in Mathematics Education. In *Research in Mathematics Education in Australasia 2012-2015* (pp. 119–141). Springer Singapore. https://doi.org/10.1007/978-981-10-1419-2_7

Ginting, S., Darmayanti, T. E., Wianto, E., & Yuwono, A. A. (2025). Harapan dan Kenyataan: Implementasi Kurikulum Pendidikan Inklusi di Sekolah Dasar Negeri: Kota Bandung. *Ideas: Jurnal Pendidikan, Sosial, Dan Budaya*, *11*(2), 9. https://doi.org/10.32884/ideas.v11i2.2129

Izzati, K. N., Yeni, P., Takahashi, H., & Santos, L. (2025). Implementation of Inclusive Teaching for Children with Special Needs: An Educational Psychology

Perspective. *Darussalam: Journal of Psychology and Educational*, *4*(1), 63–72. https://doi.org/10.70363/djpe.v4i1.197

Jung, L. A. (2025). *Every Child Deserves a Special Education: Five Mindframes That Ensure All Students Learn*. Corwin Press.

Liu, X., & Potmesil, M. (2025). A review of research on the development of inclusive education in children with special educational needs over the past 10 years: a visual analysis based on CiteSpace. *Frontiers in Education*, *9*. https://doi.org/10.3389/feduc.2024.1475876

Mardhia, A. R. N. P. (2025). Pendidikan Anak Berkebutuhan Khusus Pada Down Syndrome. *PPSDP Undergraduate Journal of Educational Sciences*, *Vol. 2 No.*(Vol. 2 No. 1 (2025)). https://doi.org/https://doi.org/10.59175/pujes.v2i1.225

Marhamah, M., Putri, R. I. I., Zulkardi, Z., & Hartono, Y. (2025). Systematic Literature Review: Mathematics Learning for Children with Special Needs. *Indiktika : Jurnal Inovasi Pendidikan Matematika*, *7*(2), 589–602. https://doi.org/10.31851/indiktika.v7i2.17016

Sağıroğlu, N., Uzunboylu, H., Akçamete, G., & Demirok, M. S. (2025). The Effect of a Mathematics Learning Disability Program Offered Face to Face with Interactive Online Learning from Smart Learning Environments on Teachers' Knowledge and Self-Efficacy Levels. *Applied Sciences*, *15*(10), 5326. https://doi.org/10.3390/app15105326

Samaniego López, M. V., Orrego Riofrío, M. C., Barriga-Fray, S. F., & Paz Viteri, B. S. (2025). Technologies in Inclusive Education: Solution or Challenge? A Systematic Review. *Education Sciences*, *15*(6), 715. https://doi.org/10.3390/educsci15060715

Schnepel, S., Sermier Dessemontet, R., & Moser Opitz, E. (2024). The impact of inclusive education on the mathematical progress of pupils with intellectual disabilities. *International Journal of Inclusive Education*, *28*(12), 2815–2829. https://doi.org/10.1080/13603116.2022.2132425

Surya Sari Faradiba, Sunismi, Yuli Ismi Nahdiyati Ilmi, & Fuat. (2024). Empowering Special Needs Children: Community Outreach for Inclusive Mathematics Education. *International Journal of Community Service Learning*, *8*(3), 226–235. https://doi.org/10.23887/ijcsl.v8i3.80816.