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Developing geometry pop-up book using universal design for learning approach for students with intellectual disabilities in Yogyakarta

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Abstrak: Education is a universal right for all individuals, including Children with intellectual disabilities (ID). Therefore, the study aimed to develop a valid, practical, and effective Pop-up Book using the Universal Design for Learning (UDL) approach to geometry material for students with intellectual disabilities in one of the Schools for Students with Special Needs in Yogyakarta. It used a developmental research method with the ADDIE model (Analysis, Design, Development, Implementation, and Evaluation). The population was all students with intellectual disabilities in one of the State Schools for Students with Special Needs in Yogyakarta. The sample was 10 students, selected using the purposive sampling technique. The study concluded that the Pop-up Book was valid. Based on the limited test, the results of the ten representative ability test questions were also valid and reliable. Moreover, the pop-up book developed was practical from the student's perspective. The average pre-test and post-test results effectively improved the learning outcomes of students with intellectual disabilities in geometry material. Thus, the Pop-up Book Geometry using the Universal Design for Learning approach was valid, practical, and effective.

Keywords: Children with special needs; inclusive education; mathematics education.

Pengembangan *Pop-up Book* Geometri dengan Pendekatan Universal Design for Learning bagi Siswa Tunagrahita Yogyakarta

Abstrak: Pendidikan adalah hak universal yang tak terpisahkan bagi semua individu, tak terkecuali anak-anak tunagrahita. Karena itu penelitian ini bertujuan mengembangkan *Pop-up Book* yang valid, praktis dan efektif dengan pendekatan *Universal Design for Learning* (UDL) pada materi geometri untuk siswa tunagrahita di salah satu SLB Negeri yang ada di Kota Yogyakarta. Metode penelitian yang digunakan metode penelitian pengembangan dengan model ADDIE *(Analysis, Design, Development, Implementation, dan Evaluation)*. Populasi dalam penelitian yaitu seluruh siswa tunagrahita di salah satu SLB Negeri yang ada di Kota Yogyakarta. Sampel yang digunakan yaitu 10 siswa tunagrahita dengan pemilihan purposisve sampling. Hasil penelitian diperoleh beberapa kesimpulan, antara lain *Pop-up Book* tersebut valid. Dari uji terbatas diperoleh hasil kesepuluh soal tes kemampuan representatif juga valid dan reliabel. *Pop-up Book* yang dikembangkan juga praktis dari sisi siswa. Dan hasil rata-rata *pre-test* dan *post-test* efektif meningkatkan hasil belajar siswa tunagrahita pada materi geometri. Dengan begitu perangkat pembelajaran *Pop-up Book* Geometri dengan pendekatan *Universal Design for Learning* dapat dikatakan valid, praktis dan efektif.

Kata Kunci: Anak berkebutuhan khusus; pendidikan inklusi; pendidikan matematika.

INTRODUCTION

Education plays a crucial role in life, and every human being has the right to receive an education. Education is a lifelong process and should be accessible to all, including children with special needs (ABK), who also deserve an education (Alpian et al., 2019). In line with the

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goal of inclusive education, the educational service system enables children with special needs to learn together in regular schools (Rusmono, 2020). Therefore, the right to education also applies to children with special needs.

Children with special needs have unique characteristics in their types and characteristics, that make them different from other children. The main challenge for educators and parents lies in the difficulty these children face in interacting with others. Then, a deep understanding and a specialized teaching approach are needed to explore and optimize their potential (Husna et al., 2019).

Children with special needs with intellectual disability have a different thinking process compared to other children (Laja et al., 2021). Intellectual disability is a term for children who experience intellectual delays. The classification of intellectual disability is measured by the IQ levels and is divided into three categories; mild, moderate, and severe (Tarigan, 2019). They have difficulty using language to express their thoughts and feelings. As a result, they also face challenges in adapting and behaving (Fadiana & Rosalina, 2020). Cognitive limitations made it difficult to understand mathematical concepts.

Mathematics is a subject that involves abstract concepts and requires logical thinking skills, that need a deeper learning approach (Nurfaidah et al., 2020). Mathematics is also taught to students with intellectual disabilities in Schools for Students with Special Needs (SLB), including geometry, a branch of mathematics. Geometry learning may contribute to developing the knowledge, mindset, attitudes, and skills of students with intellectual disabilities. The concepts of geometric and spatial shapes are abstract ideas taught in mathematics learning (Yunaini & Arnidha, 2022).

Learning for children with special needs (ABK) requires an appropriate strategy that meets their specific needs, such as those with intellectual disabilities who often have difficulty distinguishing geometric shapes. This study proposed a solution by using the Pop-up Book media based on the Universal Design for Learning (UDL) approach.

Learning media in teaching and learning activities also plays an important role (Arip & Aswat, 2021). One example of effective learning media is the pop-up book. Its engaging three-dimensional elements encourage students to actively explore geometry material. This medium provides a visual and tactile experience that enhances learning and makes it more dynamic and engaging (Wulan & Astutik, 2023).

Universal Design for Learning (UDL) is a concept used in developing inclusive learning media for students with disabilities. This design is believed to be an appropriate form of full inclusion because it invites all learners and helps reduce barriers for students with disabilities (Dharma, 2019). Moreover, the concept allows teachers to create accessible learning media for all students, including those with special needs. It also makes learning materials easier to understand by adapting the media to the abilities and needs of students with disabilities.

One concept that can be utilized in developing inclusive learning media for students with disabilities is Universal Design for Learning (UDL). UDL is a philosophical framework rooted in cognitive neuroscience research that examines the brain's learning processes. This framework is widely employed to create educational environments that are inclusive and accessible to a

variety of learners, including students with disabilities (Alquraini & Rao, 2020; Capp, 2017; Chita-Tegmark et al., 2012; Rao, 2015). The Center for Applied Special Technology (CAST) developed the UDL framework based on three core principles: representation, expression and action, and engagement (Center for Applied Special Technology, 2018).

In a study conducted by Schreffler et al. (2019), a literature review was performed to examine the application of UDL for students with disabilities. The findings indicated that the implementation of UDL principles significantly contributes to STEM teaching at the post-secondary level, particularly in instructional approaches used by teachers and in enhancing self-advocacy among students with disabilities.

Therefore, it is important to develop learning media based on Pop-up Books using the Universal Design for Learning (UDL) approach, specifically for students with intellectual disabilities in geometry education. The aim of this research is to explore how the use of Pop-up Books can enhance the understanding of geometry concepts through the Universal Design for Learning (UDL) approach for students with intellectual disabilities. Additionally, this study also aims to evaluate the validity and practicality of using Pop-up Books through the Universal Design for Learning (UDL) approach in geometry education for students with intellectual disabilities. Thus, the development of Pop-up Book learning media using the Universal Design for Learning (UDL) approach is expected to be an effective solution for improving the understanding of geometry concepts among students with intellectual disabilities, as well as providing a more comprehensive perspective on the impact of using this medium in the context of inclusive education.

METHOD

The research was a research and development study that adopted the ADDIE design (Analysis, Design, Development, Implementation, and Evaluation) (Sugiyono, 2019). The ADDIE model is a learning development framework that consists of five stages, namely needs analysis, design, development, implementation, and evaluation (Figure 1).

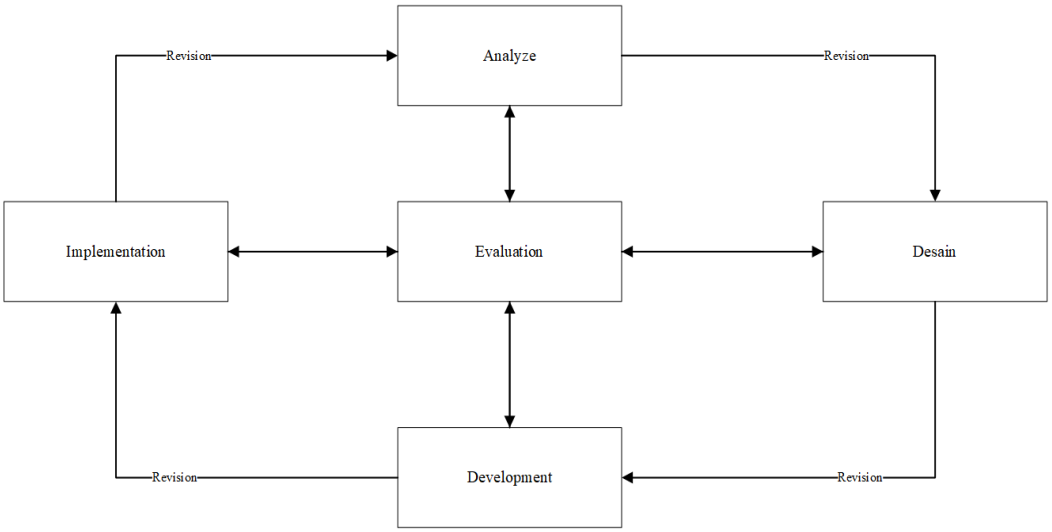

Figure 1. ADDIE Model (Sugiyono, 2019)

The population consisted of students with intellectual disabilities in a state school for students with special needs in Yogyakarta. The sample was selected using a purposive sampling technique, specifically involving students with intellectual disabilities who have limited understanding and difficulty in learning geometry material. The samples consisted of 10 students, categorized as having mild to moderate intellectual disabilities.

The research was conducted at a state school for students with special needs in Yogyakarta over a period of three months.The instruments used were pre-test, post-test, and questionnaire. The pre-test was used to measure students' initial abilities in geometry before the implementation of learning using the pop-up book. Meanwhile, the post-test was used to measure students' understanding after learning geometry with the pop-up book based on the Universal Design for Learning (UDL) approach. The questionnaire was used to collect data on students' responses regarding the practicality of using pop-up book media using the Universal Design for Learning (UDL) approach in geometry learning.

The first stage is needs analysis, conducted through observations and interviews with intellectual disabilities related to their needs and difficulties in learning geometry. This stage also determines the curriculum for media development. The second stage is design creation, where Pop-up Book media using the Universal Design for Learning (UDL) approach is designed and adapted to the needs and learning characteristics of students. The third stage is development, where the pop-up book media is produced, validated, and tested on a number of students. After that, media improvements are made based on the results of validation and product trials. The validation result criteria are presented according to (Arikunto, 2006) in Table 1.

Table 1. Validity Criteria

Correlation Coefficient	Validity Criteria
$0{,}81 - 1{,}00$	Very high
$0{,}61 - 0{,}80$	High
$0{,}41 - 0{,}60$	Fairly
$0{,}21 - 0{,}40$	Poor
$0{,}00 - 0{,}20$	Very Poor

The fourth stage is implementation, where the pop-up book media is applied in geometry learning. The final stage is evaluation , during which student learning outcomes are measured through tests and their responses to the use of pop-up book media based on the Universal Design for Learning (UDL) approach. The level of effectiveness is categorized into several criteria, as explained by Damopolii et al. (2023) in Table 2.

Table 2. Effectiveness Criteria

Score Range	Effectiveness Level
$1{,}0 - 1{,}75$	Ineffective
$1{,}75 - 2{,}5$	Fairly Effective
$2{,}5 - 3{,}25$	Effective
$3{,}25 - 4$	Very Effective

The data analysis technique used both descriptive and inferential methods. Descriptive analysis was conducted to describe the data characteristics, including mean, median, mode, and standard deviation. This analysis provides an overview of the level of student achievement in mastering geometry material after using Pop-up Book media using the Universal Design for Learning approach and to determine the validity of pop-up book media. Inferential analysis was employed to test the hypothesis. Meanwhile, data from the questionnaire were analyzed using frequency analysis to calculate the distribution of answers to the questionnaire statements.

FINDING AND DISCUSSION

Pop-up Book learning media on geometry material was developed using the ADDIE model to produce learning media that is valid, practical, and effective. The results of the study are as follows.

Analysis

The development stage began with a needs analysis through an in-depth analysis of the needs of students with intellectual disabilities in understanding and mastering the concept of geometry. Observations and interviews were conducted to identify the obstacles and challenges faced during the learning process. Interviews were conducted with six students, as follows:

Based on the interviews with students with intellectual disability regarding the obstacles and challenges in learning geometry,as well as the learning media needed, the conclusions are as follows:

1. Difficulty in Understanding the Geometry Concepts: Students reported difficulties in understanding the concept of three-dimensional shapes, changes in shape, and interactions between objects.
2. Need for Real Visualization: Most students expressed a preference for learning through visual aids such as pictures, physical models, toys, and contrasting colored media. This highlights the importance of real visualization in learning.
3. Limited Interest and Focus: Some students showed a lack of interest and focus when learning activities were unengaging, particularly when presented through long texts or oral explanations without visual support.
4. Enthusiasm for Pop-up Books: Students believed that pop-up books have the potential to support their understanding of spatial figures. They hoped such books would offer a better visual experience and help them recognize three-dimensional shapes more clearly.
5. Active Involvement in Learning: Students responded positively when it involves hands-on activities, experiments, games, and outdoor classes, especially those involving three-dimensional shapes in everyday life.
6. Need for a Contextual Approach: Students expressed the need for real-life examples and relatable stories to everyday life to help them grasp the concept of spatial figures more effectively.

7. Importance of Touch and Interaction: Some students stated that direct interaction, such as touching physical objects, significantly aided their understanding of the material.

These findings conclude that a learning approach that prioritizes real visualization, active interaction, and contextualization of concepts is a key to helping students with intellectual disabilities to understand geometry material better. Pop-up books and other media that offer visual and interactive experiences are also effective tools in the learning process.

A prediction analysis was carried out for learning activities after interviews with students with intellectual disability, presented in Table 3.

Table 3. Predictions for learning activities

Activity	Activity Description	Possibility of Student Thinking
Reading the learning outcomes and learning objectives.	Students read each learning achievement and learning objective	- Students do the skim read - Students read in detail - Students can recall each learning achievement and learning objective
Matching pictures of objects with geometric shapes	Students observe pictures of objects and try to compare them with the geometric shapes that have been studied	- Milk cartons are similar to blocks because they have rectangular sides - Milk cans are cylinders because they have two circular sides and one curved side
Determining geometric shapes based on the sides and angles	Students observe pictures of geometric shapes and count the number of sides and angles	- This shape has a triangular base and a triangular upright side, so it is a pyramid - This shape has two circular sides, so it is a cylinder
Representing geometric shapes from of their nets	Students try to represent the net shape of a geometric shape	- If this net is folded, it will form a cube because all its sides have the same size - These nets have two circles and a rectangle, which might establish a cylinder
Determining the number of sides of a cube	Students try to remember and imagine the shape of a	- A cube is like a box with all sides the same size, so it must have many sides

Activity	Activity Description	Possibility of Student Thinking
	cube and count the number of sides	- I once made a cube out of paper, I remember there were 6 sides
Determining the number of sides of a square pyramid	Students try to remember and imagine the shape of a square pyramid and count the number of sides	- A pyramid has a peak, so it must have fewer sides than a cube - I'm confused. I try to count the sides one by one
Identiftying a geometric figure with 5 angles	Students imagine the shape of a geometric figure with 5 angles and try to match it with the answer choices	- A geometric figure with 5 angles and must be pointed at the top, so it might be a pyramid - I'm confused, all geometric figures have angles
Identifying a geometric figure with a base, cover, and lid	Students imagine the shape of a geometric figure that has these components	- A figure that has a base, cover, and lid must be a cylinder like a can - I'm confused, all geometric figures have bases and lids

To ensure that the learning media accommodates the learning needs of students with intellectual disabilities, the principles of Universal Design for Learning (UDL) are applied in the development of the Pop-up Book on Spatial Shapes. UDL emphasizes three main aspects: engagement, representation, and action and expression (Center for Applied Special Technology, 2018). The application of UDL principles in the design of the Pop-up Book media is presented in Table 4.

Table 4. Mapping of UDL Principles in the Pop-up Book on Spatial Shapes

UDL Principle	Explanation	Implementasi in the *Pop-up Book*
Engagement	Keeping students interested and focused	- Attractive illustrations and bright colors. - 3D pop-up elements of geometric solids that attract students' interest when opening the book. - Relevant visual context of geometric solids.. - Fun string-webbing activity to form complete solid shapes.

UDL Principle	Explanation	Implementasi in the *Pop-up Book*
		- The properties of the solids are presented in a Waterfall Card format that students can pull out.
Representation (Representasi)	Providing multiple ways of presenting information	- 3D pop-up visuals help concretely understand geometric shapes. - Equipped with written descriptions (name of shape, area/volume formulas). - Images and background icons of the Pop-Up Book support understanding of solid shapes. - Uses simplified mathematical vocabulary.
Action & Expression	Enabling students to express understanding in various ways	- The pop-up can be opened and closed without extra tools. - The book is large enough to be easily held by students. - Students are asked to identify solid shapes by opening certain parts of the book. - There are activities to guess the solid shapes based on their visual features.

The analysis results of possible occurrences during the learning process as well as the representation principle in the UDL framework were used as a reference in creating the Pop-Up Book concept. Subsequently, a layout analysis was performed to create an efficient and user-friendly pop-up book layout. This analysis produced the main layout, which served as the design model for the development of the pop-up book. It is presented in Figure 2.

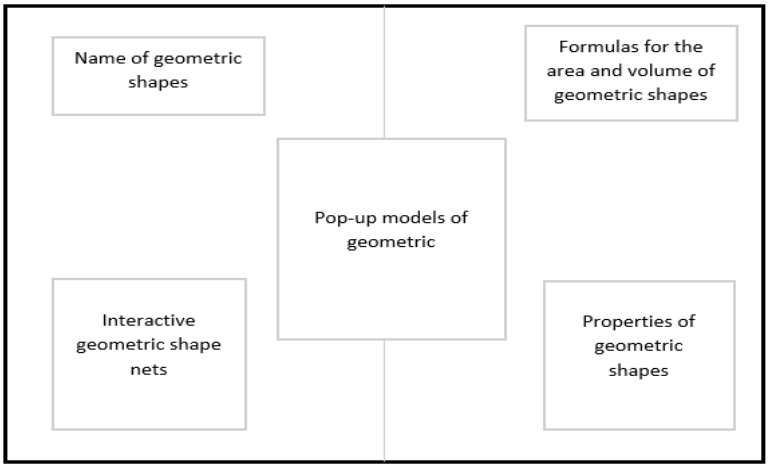

Figure 2. Layout model of Pop-up Book media

Design

After understanding the student's needs, the next stage is to design the appropriate pop-up book media. The design of this media refers to the learning characteristics of students with intellectual disabilities, including their visualization abilities, motor skills, and learning preferences.

Geometry materials are selected and arranged systematically, starting from basic concepts to more complex ones. The shape and layout of the pop-up book pages are carefully considered to ensure they are easy to understand for students with intellectual disabilities. The Pop-up Book media is designed appropriately for students with intellectual disabilities. Figure 3 shows the pop-up B=book design for students with intellectual disabilities.

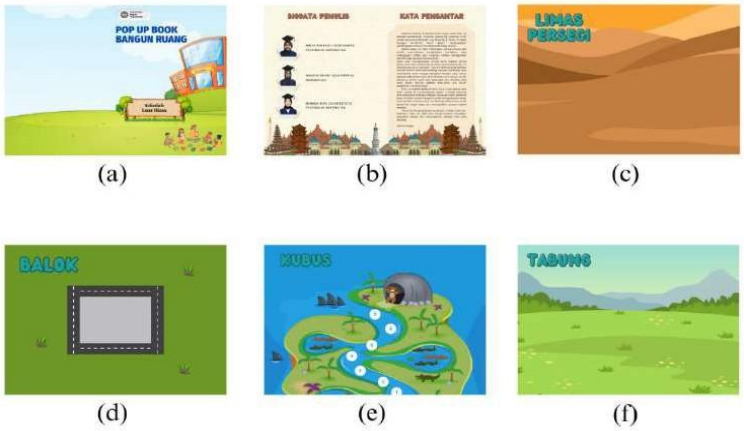

Figure 3. Pop-up Book Design: (a) cover, (b) author identity, (c) square pyramid, (d) cuboid, (e) cube, and (f) cylinder

Development

After the design stage, the Pop-up Book media proceeded to the validation stage, which aimed to assess the feasibility of the design. The validation process identified several weaknesses of the Pop-up Book media in the initial design. Based on the feedback from validators, the Pop-up Book media was revised and improved in accordance with their suggestions. These improvements ensured that the media became feasible and ready for testing with the target student group.

At the expert appraisal stage, several experts evaluated the Geometry Pop-up Book media. The results of the expert validation were used as a reference for revising and improving the Geometry Pop-up Book media. In this validation, the product's feasibility received an overall mean score of 3.39 which falls under the 'valid' category.

This Geometry Pop-Up Book media underwent a validation process by two experts, namely a media expert and a material expert. The validation results were used as a reference for revising and improving the media. In the validation test, this media obtained a level of feasibility with a mean score of 0.86. Referring to the V-Aiken value category, it can be concluded that the Geometry Pop-Up Book media has a high level of validity. Thus, this media is considered for implementation with students.

Implementation

At this stage, the Pop-Up Book is ready for a limited trial. The display of the Pop-Up Book media is presented in Figure 4.

FIgure 4. Media of *Pop-Up Book*

The initial condition of low student learning outcomes, limited interest, and low motivation in participating in mathematics learning, especially in spatial geometry material, was identified as suboptimal. Students had difficulty practicing similar questions. Moreover, they were not very active in participating in spatial geometry learning. This situation is considered an indicator of the need to improve the quality of the learning process and outcomes, especially in the subject of spatial geometry. The result of *pre-test* and *post-test* are presented in Table 5.

Table 5. Result of Pre-test and Post-test

No	Description	Pre-Test	Post-test
1	Lowest Score	10	90
2	Highest Score	60	100
3	Mean	36,43	97,14
4	Range	50	10
5	Standard Deviation	14.92	4.08
6	Variation	222,98	16.65

Table 6. Frequency Distribution of Pre-test and Post-test Score

Score Interval	Pre-Test	Post-test
10-29	1	0
30-49	4	0
50-69	2	0
70-89	0	0
90-109	0	7

Based on Table 6, the implementation of Pop-up Book using the Universal Design for Learning (UDL) approach on the material of geometry had a positive impact on improving students' learning comprehension. This is evidenced by higher mean scores, narrower score ranges, and lower standard deviations on the post-test, indicating reduced variability and more consistent student performance following the intervention. The frequency distribution

further shows that the majority of students achieved high scores on the post-test. These findings suggest that the intervention was effective in enhancing students' overall learning outcomes in geometry.

Table 7. Result of T-Test

Statistic	**Score**
T count	-10.371
Df	6
P-value	4.704e-05
Confidence Interval for Difference 95%	-77.68767
Mean	-48.02662
Estimated Mean Difference	-62.85714

Table 7 shows the result of inferential analysis, tested using a paired t-test with an r software, showing a calculated t-value of -10.371 and degrees of freedom 6 and a p-value of 4.704e-05 (very small, much smaller than the significance level of 0.05). This indicates a significant difference between the mean of pre-test and post-test. In other words, students' learning outcomes significantly increased after the intervention using Pop-up Book with the Universal Design for Learning (UDL) approach to spatial geometry material. In addition, the 95% confidence interval for the mean difference is between -77.68767 and -48.02662. This means that, with a 95% confidence level, the pre-test and post-test mean difference is on these ranges.

Thus, the paired t-test analysis showed a significant difference between the pre-test and post-test means. The intervention using a Pop-up Book with the Universal Design for Learning (UDL) approach was statistically proven to improve student learning outcomes. The estimated average difference of around -62.85714 indicates a substantial increase in student learning achievement after the intervention.

To determine the effectiveness of the learning provided, an analysis was conducted on the improvement of students' scores using the n-gain value. The n-gain value reflects the extent to which students improved from the pretest to the posttest, with the following classification categories: High (n-gain > 0.7), Medium (0.3 ≤ n-gain ≤ 0.7), and Low (n-gain < 0.3). The following table shows the distribution of students based on the n-gain categories along with the percentage of achievement.

Tabel 8. Distribution of Students Based on N-Gain Categories

N-gain level	Number of Students	Percentage (%)	Completion Status
High	7	70	Completed
Medium	3	30	Completed
Low	0	0	-
Total	10	100	100% completed

Furthermore, the processed data from the questionnaire on 10 students with the intellectual ability to determine the practicality of Pop-up Book.

Table 9. Practicality Data Processing

Category	Score	Interval	Frequency
Strongly Agree	5	≥ 82%	1
Agree	4	78-81%	6
Fair	3	72-77%	3
Disagree	2	57-71%	0
Strongly disagree	1	≤56	0
Total			10

Table 9 shows the highest frequency falls within the interval of 78-81%, which corresponds to the category of agreeing with the practicality of the Pop-up Book media. Based on these results, it can be concluded that the Pop-up Book is practical for use by students in special schools (SLB) as a learning medium that effectively facilitates the understanding of spatial geometry concepts.

Evaluation

Evaluation is the final stage in the ADDIE learning media design model. It aims to assess the effectiveness and value of the developed teaching materials. Evaluation is carried out in a formative evaluation at the end of the face-to-face meeting that measures the final competency or learning objectives. The evaluation results are used to provide feedback on the development of teaching materials. Then, revisions are made based oon the evaluation findings or to address aspects that have not yet fulfilled the objectives of the material development (Cahyadi, 2019).

Learning experiences facilitated by Pop-up Books based on the Universal Design for Learning (UDL) approach have been shown to improve the learning outcomes of students with intellectual disabilities. The implementation of the geometry Pop-up Book followed a thorough development process and classroom application. This media was tested, applied in instructional settings, and evaluated for potential weaknesses. Based on the assessments of validity, practicality, and effectiveness, the Pop-up Book meets the criteria in all three aspects.

The implementation of the spatial geometry Pop-up Book demonstrated a significantly higher learning outcome among students with intellectual disability compared to those who did not use the Pop-up Book of spatial geometry media. Supported by a study (Lutfi & Munizu, 2023) that the use of Pop-up Book media has an effect on improving the learning outcomes of students with intellectual disability. Furthermore, research by (Kasmawati et al., 2023) states that there is an enhances the ability to recognize spatial shapes in students with intellectual disability.

The implementation of learning using Universal Design for Learning (UDL) includes three main components, namely: (1) Advocacy, which was carried out by communicating persuasively. It intends to build awareness for all parties, teachers, and students about the concept of diversity. This stage is expected to create an awareness of the diverse needs of each student, a sense of mutual respect, and self-confidence, and motivate each other. (2) Accommodation. In this stage, teachers are required to design learning that can accommodate all the diverse interests of students. Teachers must map or identify the diversity of student

learning styles, diversity of interests, and assessments. Thus, teachers are motivated to design various accommodations in learning to meet the diverse students' needs. (3) The accessibility stage is the most anticipated stage, where a learning environment is created and engineered to accommodate the diversity of students. Ultimately, this ensures that all students' learning needs are effectively met.

CONCLUSION

Based on the findings and discussion, it can be concluded that the development of the Pop-up Book with the Universal Design for Learning (UDL) approach for geometry material has a positive impact on improving the understanding and learning outcomes of students with intellectual disabilities. This conclusion is supported by the results of descriptive and inferential analysis of pre-test and post-test data, which indicate the use of Pop-up Book media has statistically improved learning outcomes. In addition, the results of the practicality test indicate that this Pop-up Book is practical for students in special education schools (SLB) as a medium that enhances their understanding of spatial shapes.

Thus, the development of the Pop-up Book using the Universal Design for Learning (UDL) approach has demonstrated both practicality and effectiveness in teaching geometry material to students with intellectual disabilities at one of the state SLBs in Yogyakarta.

The Pop-up book media for geometry material at the junior high school level has been found to be valid, practical, and effective. Its validity is proven by an average score of 0.86. In terms of practicality, this media falls within the 78–81% interval, which corresponds to the "agree" category regarding its practical use. The test results in measuring effectiveness obtained a p-value of 4.704e-05, which is very small and below the significance level of 0.05. This indicates a significant difference between the mean of pre-test and post-test. In other words, student learning outcomes improved significantly after using pop-up books using the Universal Design for Learning (UDL) approach for spatial geometry material. Therefore, this learning media may serve as an effective alternative to help students who struggle to understand geometry material. However, this study focused solely on comparing student scores before and after the intervention. Further research is recommended to examine the relationship between student achievement and factors such as learning motivation or anxiety levels.

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REFERENCES

Alpian, Y., Anggraeni, S. W., Wiharti, U., & Soleha, N. M. (2019). Pentingnya pendidikan bagi manusia. *Jurnal Buana Pengabdian*, *1*(1), 66-72. https://doi.org/10.36805/jurnalbuanapengabdian.v1i1.581

Alquraini, T. A., & Rao, S. M. (2020). Assessing teachers' knowledge, readiness, and needs to implement universal design for learning in classrooms in Saudi Arabia. *International Journal of Inclusive Education*, *24*(1), 103-114. https://doi.org/10.1080/13603116.2018.1452298

Arikunto, S. (2006). *Prosedur penelitian: Suatu pendekatan praktik (Edisi revisi)*. Jakarta: Rineka Cipta.

Arip, M., & Aswat, H. (2021). Media pop up book untuk meningkatkan hasil belajar siswa pada mata pelajaran IPA di sekolah dasar. *Edukatif: Jurnal Ilmu Pendidikan*, *3*(1), 261–68. https://doi.org/10.31004/edukatif.v3i1.329

Cahyadi, R. A. H. (2019). Pengembangan bahan ajar berbasis ADDIE model. *Halaqa: Islamic Education Journal*, *3*(1), 35–42. https://doi.org/10.21070/halaqa.v3i1.2124

Capp, M. J. (2017). The effectiveness of universal design for learning: a meta-analysis of literature between 2013 and 2016. *International Journal of Inclusive Education*, *21*(8), 791-807. https://doi.org/10.1080/13603116.2017.1325074

Center for Applied Special Technology. (2018). *Universal design for learning guidelines version 2.2*. Wakefield, MA: National Center on Universal Design for Learning. http://udlguidelines.cast.org

Chita-Tegmark, M., Gravel, J. W., Maria De Lourdes, B. S., Domings, Y., & Rose, D. H. (2012). Using the universal design for learning framework to support culturally diverse learners. *Journal of Education*, *192*(1), 17–22. https://doi.org/10.1177/002205741219200104

Damopolii, V., Bito, N., & Resmawan, R. (2023). Efektivitas media pembelajaran berbasis multimedia pada materi segiempat. *ALGORITMA: Journal of Mathematics Education*, *1*(2), 74-85. https://doi.org/10.15408/ajme.v1i2.14069

Dharma, D. S. A. (2019). Analisis kualitas rencana program pembelajaran berbasis universal design for learning pada mata pelajaran ilmu pengetahuan sosial. *Khazanah Pendidikan*, *13*(1), 15-40. https://doi.org/10.30595/jkp.v13i1.6177

Fadiana, M. J., & Rosalina, C. D. (2020). Peningkatan rasa percaya diri siswa tunagrahita melalui pembelajaran terintegrasi semiotik dengan media buku pop up. *Dinamisia: Jurnal Pengabdian Kepada Masyarakat*, *4*(2), 373–83. https://doi.org/10.31849/dinamisia.v4i2.3940

Husna, F., Yunus, N. R., & Gunawan, A. (2019). Hak mendapatkan pendidikan bagi anak berkebutuhan khusus dalam dimensi politik hukum pendidikan. *SALAM: Jurnal Sosial Dan Budaya Syar-I*, *6*(2), 207–22. https://doi.org/10.15408/sjsbs.v6i1.10454

Kasmawati, St., Meidina, T., Bastiana, & Sulaminah, D. (2023). Peningkatan kemampuan mengenal bangun ruang melalui penggunaan media pop up book pada siswa hambatan intelektual kelas II di SLB Negeri 1 Kabupaten Gowa. *Trihayu: Jurnal Pendidikan Ke-SD-an*, *9*(2), 187–95. https://doi.org/10.30738/trihayu.v9i2.14751

Laja, Y. P. W., J. Simamarta, & Mone, F. (2021). Proses berpikir siswa tunagrahita ringan dalam memahami konsep geometri berdasarkan teori Jean Piaget. *AKSIOMA: Jurnal Program Studi Pendidikan Matematika*, *10*(4), 2417–2423. https://doi.org/10.24127/ajpm.v10i4.4180

Lutfi, M., & Munizu, M. (2023). Peningkatan hasil belajar peserta didik tunagrahita ringan SDLB melalui media pop up book pada mata pelajaran matematika di SLB Negeri Brebes. *Jurnal Konseling Pendidikan Islam*, *4*(1), 120-125. https://doi.org/10.32806/jkpi.v4i1.48

Nurfaidah, N., Sudirman S., & Mellawaty, M. (2020). Bagaimanakah cara siswa tunagrahita ringan dalam menyelesaikan soal operasi hitung pembagian?: Exploratory case study dalam menggunakan media kotak puzzle geometri. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *11*(2), 143–52. https://doi.org/10.15294/kreano.v11i2.25930

Rao, K. (2015). Universal design for learning and multimedia technology: Supporting culturally and linguistically diverse students. *Journal of Educational Multimedia and Hypermedia*, *24*(2), 121-137.

Rusmono, D. O. (2020). Optimalisasi pendidikan inklusi di sekolah: Literature review. *Kelola: Jurnal Manajemen Pendidikan*, *7*(2), 209–217.

Schreffler, J., Vasquez III, E., Chini, J., & James, W. (2019). Universal design for learning in postsecondary STEM education for students with disabilities: A systematic literature review. *International Journal of STEM Education*, *6*(1), 1-10 https://doi.org/10.1186/s40594-019-0161-8

Sugiyono. (2019). *Metode penelitian pendidikan (kuantitatif, kualitatif, kombinasi, R&D dan penelitian pendidikan)*. Bandung: Alfabeta.

Tarigan, E. (2019). Efektivitas metode pembelajaran pada anak tunagrahita di SLB Siborong-Borong. *Jurnal Pionir LPPM Universitas Asahan*, *5*(3), 56–63. https://doi.org/10.36294/PIONIR.V5I3.731

Wulan, D. A. N., & Astutik, L. S. (2023). Pengembangan media pop-up book pada materi siklus air untuk siswa kelas 4 SDN 1 Waung. *Elementary School Teacher*, *6*(1), 10-21. https://doi.org/10.15294/k99kbf43

Yunaini, N., & Arnidha, Y. (2022). Pengaruh pembelajaran berbasis teori Van Hiele terhadap pemahaman bangun ruang kubus geometri siswa tunagrahita. *Journal Of Elementary School Education (JOuESE)*, *2*(2), 128–134. https://doi.org/10.52657/jouese.v2i2.1774