

Mathematics Teaching-Learning for Students with Intellectual Disabilities: Systematic Literature Review Year 2010-2020

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ABSTRACT

Students with intellectual disabilities have the right to learn all academic fields, including mathematics which is often considered a difficult subject. This study aims to review all the research results that have been carried out from 2010 to 2020 related to learning mathematics in students with intellectual disabilities. This research is a Systematic Literature Review. The search was carried out on the literature available online. Analysis of the results of the literature review is carried out by categorizing based on: methodological design, level, and category of intellectual disability, mathematical content, and type of intervention/learning. A total of 250 studies met the inclusion criteria, but only 77 studies passed the next screening stage. Among the 77 studies, only 28 were included in the final analysis. The trend of the research method used is classroom action research (n=12), experimental one group pretest-posttest (n=10), research development (n=4), and single-subject research (n=2). The results of the analysis showed that 25 studies of learning were carried out in the mild category of disability and the remaining 3 in the moderate category. The most studied at the elementary school (special school) (n=20), elementary school (regular school) (n=4), special junior high school (n=3), high school (n=1). The results of the search and analysis on the type of intervention or learning were carried out in the form of media (n=16) and methods/strategies (n=10) and a combination of both (n=2). The mathematics content taught includes computation/number operations (n=17), number concepts (n=5), currency (n=3), place value (n=2) and spatial structure (n=1). Overall research in these journals still faces different challenges.

Keywords: *Mathematics Teaching-Learning, Students with Intellectual Disability*

1. INTRODUCTION

Conceptually, individuals with intellectual disabilities are characterized by significant limitations in intellectual functioning and adaptive behavior reflected in conceptual, social, and practical adaptive skills. These disabilities occur before the age of 18 (Schalock et al., 2007). One aspect that supports independence and is part of adaptive behavior is academic ability. Some activities undertaken by children with intellectual disabilities both at home and at school often have to be completed using mathematical skills. Therefore mathematics is an important component that is learned in everyday life. Mathematics is an important indicator of academic success and an important factor in the skills needed after a child graduates (Duncan et al., 2007) especially in solving everyday problems such as cooking, purchasing, money-using skills, as well as in the work aspect (John A. Van de Walle, 2007; Peltier, Vannest, & Marbach, 2018; Ratnengsih, 2021). Although most children with intellectual disabilities often experience difficulties and even failures (Cawley, Parmer, Foley, Salmon, & Roy, 2001). So this is a challenge for teachers in teaching them in the field of mathematics.

Many studies discuss mathematics learning. Previous research that explored the impact of learning or using certain media, both conventional and technology-based, for example, Geogebra software on mathematical abilities was carried out using (Juandi, Kusumah, Tamur, Perbowo, & Tanu, 2021). Other research that has been done in America in the form of tracing is related to various interventions and their maintenance carried out on math skills for students with disabilities (Park, Bouck, & Josol, 2020). Another search research related

to mathematics learning was carried out in early childhood, namely children under four years of age (MacDonald & Murphy, 2019). In Indonesia, Amalina (2020) conducted research on learning mathematics for Early Childhood (Amalina, 2020). However, there has been no search on learning mathematics for students with intellectual disabilities that have been carried out in Indonesia

Children with intellectual disabilities conceptually experience obstacles in two ways, which are the inhibition of intellectual function and the aspect of adaptive behavior. These two things raise problems in more specific aspects which are both of them. In general, the problems faced by children with intellectual disabilities are deficits in aspects of self-regulation, attention, language, motivation, memory, and social development (Hallahan, Kauffman, & Pullen, 2014). The problems faced by students with intellectual disabilities will also affect how they learn mathematics.

The National Council of Teachers of Mathematics (NCTM, 2000) has one principle, namely equity. Where the opportunity to learn mathematics needs to be provided opportunities for all students regardless of gender, race, or intellectual ability. The assumption that mathematics can only be learned by a few students who are able to learn mathematics is being challenged that all have valuable hopes and opportunities to become an important component that must be in the mathematics curriculum. So some students may be different and require accommodation that must be supported by the school.

Students with intellectual disabilities are those who need accommodation in learning mathematics. Mathematics learning for students with intellectual disabilities focuses more on teaching numbers and operations (ie, addition, , division, multiplication, subtraction,), geometry, and algebra (Hudson, Rivera, & Grady, 2018). Some of the difficulties often faced by children with intelligence barriers in learning mathematics are as follows: 1) Barriers to the Basic Facts of Numbers; 2) Difficulties related to spatial, distance, and serialization; 3) Difficulty understanding time, value for money, and use of shopping; 4) Difficulty with abstract symbols used in mathematics; and 5) Barriers to addition and subtraction of numbers. The study (Hudson, Rivera, & Grady, 2018). further revealed that students with Down Syndrome showed more challenges than non-syndromic intellectual disability students, in addition, to subtraction, number symbols, and number identification.

Various information related to learning mathematics is based on the results of searches conducted not in Indonesia, so it is necessary to search for various problems raised in learning mathematics and learning methods for the Indonesian context. Therefore, the purpose of this study is to explore the results of research that has been carried out on learning mathematics for intellectually disabled students based on identifying methodological design, level, and category of intellectual disability, mathematical content, and type of intervention/learning.

2. METHODS

This study conducted a search and analysis of the research results that have been carried out related to mathematic learning in students with intellectual disabilities. The data entered in this study must meet predetermined criteria. First, the study deals with intellectual disability without other comorbid disabilities. Both studies are concerned with learning mathematics. Third, the study is related to empirical or using a single case experimental design or group design. Fourth, all research conducted in Indonesia was published in journals between the year 2010 to 2020.

Literature Search Procedure and Screening

Empirical data collected in this study is related to learning mathematics for students with intellectual disabilities. Data identification is done online through a Google Scholar search (<https://scholar.google.com/>). The search was carried out using the Indonesian keywords “teaching-learning mathematics” and “intellectual disability” “tunagrahita”, as well as the keywords “teaching mathematics”, “intellectual disability”, and “Indonesia”.

Figure 1 shows the literature search screening process. From the results of the first screening stage, 254 articles were obtained, and 4 articles were removed due to duplication. Then the second stage is carried out by reviewing the form of publication, whether in the form of journal publications or publication of the results of the final work of the education process at the university (thesis, thesis, and dissertation). This identification process resulted in 173 articles being excluded. The article was issued because it is in the form of a final written paper for higher education and the participants are included in intellectual disability but have comorbidities.

The articles eligible for inclusion in the next review are 77 articles. In the third stage, the collected data was reviewed on the title, abstract, and keywords (Williams, Berthelsen, Viviani, & Nicholson, 2018) to identify research results that met the eligible criteria. The results of the published research were assessed to see the focus of the research and the purpose of the review was to focus on research on learning mathematics in students with intellectual disabilities. A total of 49 articles were excluded because they were in the form of descriptive and correlation research. The final number of the four articles used for analysis was 28 articles.

Data Analysis

To see the representation of mathematics learning in students with intellectual disabilities, the researchers analyzed all data that had entered the criteria by identifying data based on categories: 1) research design; 2) participants; 3) forms of learning; and 4) math content. Next, we explain the general description descriptively referring to the data contained in each article collected on learning mathematics for students with disabilities conducted in Indonesia in the last 10 years. The analysis is also carried out with research opportunities that can be carried out in the future. This analytical model refers to a similar approach taken by other researchers (Linder & Simpson, 2018; MacDonald & Murphy, 2019).

3. RESULTS AND DISCUSSION

Figure 2 shows data on the acquisition of articles by year of publication. Our focus is on articles based on research conducted in Indonesia published in the last 10 years, from 2010 to 2020. The year with the most publications was 2013 with a total of 5 articles published. Meanwhile, in 2010, 2011, and 2019 there were no publications that met the criteria in this research study.

Methodological Trend

Table 1 shows the trend aspect of the research method used in research on learning mathematics in students with intellectual disabilities in the year 2010 to 2020. A total of 12 articles used the type of classroom action research. While as many as 10 articles the method used is an experimental one-group pr-test post-test design. A total of 4 articles used development research and the remaining 2 articles used Single Subject Research where the analysis of scores obtained after being given treatment or information was carried out individually. The results obtained cannot be generalized. Most of the findings in the classroom action research method reinforce the statement that children with special needs have different characteristics of barriers and needs so that they have the potential to cause problems in the learning classroom. To overcome substantial problems and improve classrooms, teachers themselves must become researchers and take over the research process in their classrooms (Tinto, P. P., Shelly, B. A., & Zarach, N. J., 1994).

Table 1. Distribution of Data Based on Research Methods, Types and Levels of Participants, Forms of Intervention/Learning

STUDIES	YEAR	RESEARCH METHODE	JENIS	LEVEL/GRADE	CONTENT MATHEMATICS	INSTRUCTION METHODE / MATERIAL
Jhoni Hendra	2012	Single Subject Research	Moderate	SDLB	Addition Mathematical Operation	Realistic Method
Nur Asjhadi Ramadhan	2012	Classroom Action Research	Mild	SD / 6	Whole Number	Concrete Pictorial Abstract (CPA)
Imam Juwadi	2013	Classroom Action Research	Mild	SDLB / 1	Counting 1-10	Puzzle Games
Niko Pratama, Irdamurni, Zulmiyetri	2013	Single Subject Research	Mild	SDLB / 1	Geometry	Realistic Method
Yulia Efdia	2013	Classroom Action Research	Mild	SDLB / 4	Place Value	Maze Media
Yeni Arista, Siti Masitoh	2013	Experimental one-group pretest-posttest design	Mild	SDLB / 2	Additional of Numbers 1-10	Cooperative Type Make A Match
Junaidi. As	2013	Classroom Action Research	Mild	SDLB / 3	Addition and Subtraction	Ruler Media
Widhi Astuti, Rusdiana Indianto	2014	Classroom Action Research	Mild	SDLB / 1	Multiplication	Media Concrete Objects
F. Rahmanita, A. Samawi	2014	Classroom Action Research	Mild	SDLB / 7	Number Concept	Number Card Media
Raedix Desta Kusuma	2014	Experimental one-group pretest-posttest design	Mild	SDLB / 2	Addition	Realistic Method
Abdul Huda	2014	Experimental one-group pretest-posttest design	Mild	SDLB / 2	Addition	Realistic Method
Gresila Dessy Sri Lostari, Endro Wahyuno, Tomas Irianto	2014	Quasi Experimental one-group pretest-posttest design	Mild	SMALB /10	Mathematic Learning Outcomes	Indonesia Realistic Mathematic Learning (PMRI)
Charis Fauzy	2015	Classroom Action Research	Mild	SDLB / 2	Addition	Beads Media
Nimas Ayu Winniaty Luthfa, Zaini Sudarto	2015	Experimental one-group pretest-posttest design	Mild	SDLB / 5	Addition	Token Economic Technique
Yusti Erlinda	2016	Classroom Action Research	Mild	SDLB / 4	Multiply arrange sideways	Drill Method
Luh Lina Hartariani, Made Agus Wirawan, Luh Putu Eka Damayanthi, I, I Made Gede Sunarya	2016	Research and Development (R&D) ADDIE	Mild	SDLB / 2	Number Concept, Addition, Subtraction	3D Animation Learning Media
Wika Vidiyanti, Edi Riyanto	2016	Quasi Experimental one-group pretest-posttest design	Moderate	SDLB / 3	Addition	Video-Media Expository Learning Strategy
Agung Santoso Pribadi	2016	Experimental one-group pretest-post test design	Mild	SDLB / 3	Addition	Image Media
Siti Masruroh, Edy Rianto	2017	Experimental one-group pretest-posttest design	Mild	SDLB / 1	Counting, Writing Number Symbols	Three-Dimensional Media
Nur Afifah, Zaini Sudarto	2017	Experimental one-group pretest-posttest design	Mild	SDLB / 3	Sum up to 50	Cooperative Learning Type Course Review Horay
Nela Yuni Sari Putri	2017	Classroom Action Research	Mild	SMP / 8	Currency Usage	Snakes and Ladders Game Media
Evre Rejesman Basori	2018	Experimental one-group pretest-posttest design	Mild	SD / 1	Counting	Realistic Method
Sigit Lego Wicaksono, Endro Wahyuno, Usep Kustiawan	2018	Pre-Experimental one-group pretest-posttest design	Mild	SD / 6	Currency sum	Monopoly Game Media
Dian Novitasari and Siti Mahmudah	2018	Classroom Action Research	Mild	SD / 2	Place Value	Home Number Media
Sihadi, Gesang Walujoyati, Rohana	2018	Classroom Action Research	Mild	SDLB / 1	Addition	Counting Funnel Media
Very Hendra Saputra, Dedi Darwis, Endi Febrianto	2020	Multimedia Development Life Cycle (MDLC)	Mild	SDLB	Number Concept, Computing	Mathematic Game Application
Sudiryo	2020	Classroom Action Research	Mild	SMPLB / 7	Multiplication	Ikodapat Cooperative Technique (Isi Kotak Pada Tempatnya)
Wiwik Dwi Hastuti	2020	Research and Development (R&D) method	Mild	SMPLB / 8	The Usage of Money	Media Comic
Fitri Nur Makhmudah, Siti Mahmudah	2020	Research and Development (R&D) method	Mild	SDLB / 4	Computing	Belatung Media (Belajar Berhitung) Macromedia Flash

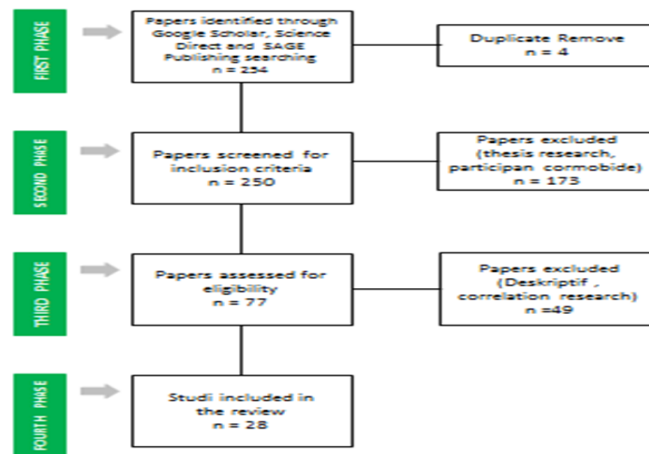


Figure 1. Diagram of Screening Process

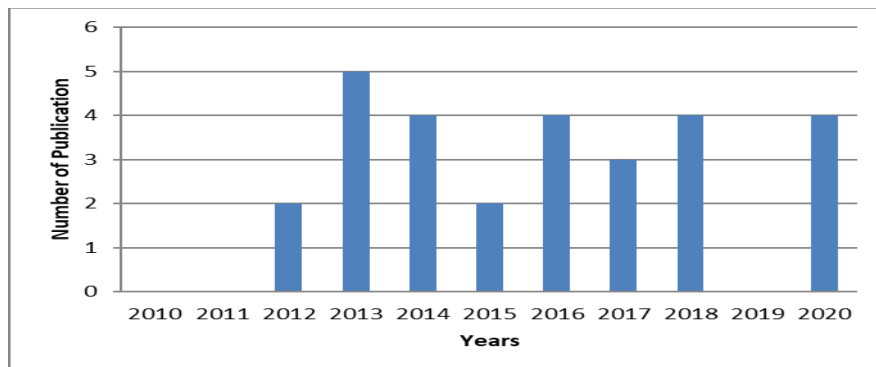


Figure 2. Publications per year

This study was conducted on students with intellectual disabilities. Table 1 shows the types of students with intellectual disabilities that were traced in the published articles as many as 35. The articles examined children with intellectual disabilities in the mild category, while only 3 articles were in the moderate category. An interesting finding is that research conducted on students with moderate barriers has the least amount. Academic aspects are often prioritized for students with mild intellectual disabilities. Although actually, Table 1 shows the distribution of education levels of students with intellectual barriers. A total of 20 articles discuss research with student participants with intellectual disabilities at the elementary school level who attend special schools and as many as 4 studies in general schools. A total of 3 participant articles consist of students with intelligence barriers at the extraordinary junior high school level and the remaining 1 article discusses at the extraordinary high school level. The results showed that many of the researchers focused on research subjects at the basic level. This is in line with the opinion of the researcher which states that numeracy learning should be carried out at a level that is still basic with the introduction of basic mathematical content as well (Goff, Wendy; Dockett, Sue; Perry, 2013). In addition, at the elementary school level, it is mostly carried out in grades 1 and 3 which are the lower classes at the elementary school level.

Mathematical Content

The mathematics content that has the most improvement in learning is computing ($n=17$), the second most is the concept of numbers ($n=5$), followed by the use of money (3), place value ($n=2$), and spatial structure (1). Various studies conducted in learning mathematics for students with intellectual disabilities focus more on computational content with the introduction of the concept of numbers. This content is conceptually an aspect that must be mastered first by students before they master aspects of other higher content. So that its

implementation is mostly carried out at the elementary school level. Content that is practical and functional is the main target that needs to be developed to support the life skills of students with intelligence barriers in everyday life. A limited number of studies examine the effectiveness of interventions teaching mathematics beyond operations and numbers. Because higher grade math content builds on basic content such as basic operations and numbers, researchers may focus on acquiring basic math skills for students with intellectual disabilities. Because the maintenance of basic math skills (eg, subtraction, addition) has an impact on the performance of students with level math content in higher grades (Powell et al., 2013).

Method and Media of Learning

Learning to improve skills in mathematical content can be done with the support of teaching methods and also teaching media. Media has the most used percentage to improve mathematics competence with different content. A total of 16 articles used the media, followed by 10 articles using the method. The study that uses both methods is equipped with media in learning mathematics consisting of 2 articles. The media that appear based on the search results are puzzles, mazes, cards, beads, three-dimensional objects, pictures, various types of games. While the types of methods consist of realistic, cooperative, token economy techniques, drills, and some combinations of methods and media.

Several studies show the use of the same method for different skill content. Even though the results of the study showed the results were effective, the variation in the effect was different. The use of more than one method in learning mathematics for students with intellectual disabilities will accelerate the mastery of mathematical skills. Likewise with the use of media. The tendency of abstract and concrete media. Given the complexity of the problems faced by children with intelligence barriers that have an impact on the learning process, the learning process for them requires various ways in a series of learning processes. The concept of using various methods as components in learning is often referred to as multi-component content or called multicomponent. So, the learning process involving various forms of learning components in mathematics can be carried out in various choices of strategies, media, and certain techniques in one learning design such as visual representation (schema), the use of virtual media, the use of assistive technology, and the involvement of other parties

4. CONCLUSION

This study was conducted as a study material to consider mathematic learning for students with intellectual disabilities. The literature search that has been carried out based on the criteria for the type of publication published over the last 11 years only resulted in 28 articles for review. This shows that little research has focused on mathematic learning for students with intellectual disabilities. Even if we look at the comparison of the number every year, it shows an increasing direction. The trend of the research method used is research with classroom action. The level of participants in various studies conducted was more for students with mild intellectual disabilities with education levels at the elementary school. The form of learning carried out with representations of the use of media and methods is that there is different content but uses the same method. The tendency to use concrete media with various types to support the principles of learning in students with intellectual disabilities can be seen in many studies conducted. Reviewing the mathematical content that has been studied shows that strengthening the basic concepts of numbers as a basic ability for mastering more complex mathematical skills is the most essential part. Functional content, especially on the use of money, shows the second most frequent study. Further research is needed to better understand the emphasis on how the use of mathematical content taught at each level of education can be applied in real life, so that, from the start, it will support strengthening the skills of students with intellectual disabilities in their everyday life.

REFERENCE

- Alberto, P. A., Troutman, A. C., & Troutman, A. C. (2006). *Seventh Edition Library of Congress Cataloging-in-Publication Data*.
- Amalina, A. (2020). Pembelajaran Matematika Anak Usia Dini di Masa Pandemi COVID-19 Tahun 2020. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, 5(1), 538. <https://doi.org/10.31004/obsesi.v5i1.592>
- Cawley, J., Parmer, R., Foley, T. E., Salmon, S., & Roy, S. (2001). Students : Implications for, 67(3), 311–328.

- Duncan, G. J., Claessens, A., Magnuson, K., Klebanov, P., Pagani, L. S., Feinstein, L., ... Japel, C. (2007). School Readiness and Later Achievement. *Developmental Psychology*, 43(6), 1428–1446. <https://doi.org/10.1037/0012-1649.43.6.1428>
- Goff, Wendy; Dockett, Sue; Perry, B. (2013). Principals View on the Importance of Numeracy as Children Start Primary School. *Non-Journal ERIC*, 0.
- Hallahan, D. P., Kauffman, J. M., & Pullen, P. C. (2014). *Exceptional Learners An Introduction to Special Education Hallahan Kauffman Pullen Twelfth Edition* (Twelfth). United States of America: Pearson New International.
- Hudson, M. E., Rivera, C. J., & Grady, M. M. (2018). Research on Mathematics Instruction with Students with Significant Cognitive Disabilities: Has Anything Changed? *Research and Practice for Persons with Severe Disabilities*, 43(1), 38–53. <https://doi.org/10.1177/1540796918756601>.
- John A. Van de Walle. (2007). *Elementary and Middle School Mathematics_ Teaching Developmentally, 6th edition (2006).pdf* (sixth). United State of America: Pearson.
- Juandi, D., Kusumah, Y. S., Tamur, M., Perbowo, K. S., & Tanu, T. (2021). Heliyon A meta-analysis of Geogebra software decade of assisted mathematics learning: what to learn and where to go? *Heliyon*, 7(April), e06953. <https://doi.org/10.1016/j.heliyon.2021.e06953>.
- Kumatongo, B. (2020). Learning of Mathematical concepts by learners with Intellectual Disabilities, (January), 0–12.
- Linder, S. M., & Simpson, A. (2018). Towards an understanding of early childhood mathematics education: A systematic review of the literature focusing on practicing and prospective teachers. *Contemporary Issues in Early Childhood*, 19(3), 274–296. <https://doi.org/10.1177/1463949117719553>
- MacDonald, A., & Murphy, S. (2019). Mathematics education for children under four years of age: a systematic review of the literature. *Early Years*, 00(00), 1–18. <https://doi.org/10.1080/09575146.2019.1624507>
- Park, J., Bouck, E. C., & Josol, C. K. (2020). Maintenance in Mathematics for Individuals with Intellectual Disability: A Systematic Review of Literature. *Research in Developmental Disabilities*, 105(May 2019), 103751. <https://doi.org/10.1016/j.ridd.2020.103751>
- Peltier, C. J., Vannest, K. J., & Marbach, J. J. (2018). A Meta-Analysis of Schema Instruction Implemented in Single-Case Experimental Designs. *Journal of Special Education*, 52(2), 89–100. <https://doi.org/10.1177/0022466918763173>
- Saunders, A. F., Spooner, F., & Ley Davis, L. (2018). Using Video Prompting to Teach Mathematical Problem Solving of Real-World Video-Simulation Problems. *Remedial and Special Education*, 39(1), 53–64. <https://doi.org/10.1177/0741932517717042>
- Schalock, R. L., Luckasson, R. A., Shogren, K. A., Borthwick-Duffy, S., Bradley, V., Buntinx, W. H. E., ... Yeager, M. H. (2007). The renaming of mental retardation: Understanding the change to the term intellectual disability. *Intellectual and Developmental Disabilities*, 45(2), 116–124. [https://doi.org/10.1352/1934-9556\(2007\)45\[116:TROMRU\]2.0.CO;2](https://doi.org/10.1352/1934-9556(2007)45[116:TROMRU]2.0.CO;2)
- Williams, K. E., Berthelsen, D., Viviani, M., & Nicholson, J. M. (2018). Facilitated Parent-child Groups as Family Support: A Systematic Literature Review of Supported Playgroup Studies. *Journal of Child and Family Studies*, 27(8), 2367–2383. <https://doi.org/10.1007/s10826-018-1084-6>
- Benson, E. E. (2008). Cryopreservation theory. In *Plant cryopreservation: a practical guide* (pp. 15-32). Springer, New York, NY. https://doi.org/10.1007/978-0-387-72276-4_2
- Geary, D. C., Nicholas, A., Li, Y., & Sun, J. (2017). Developmental change in the influence of domain-general abilities and domain-specific knowledge on mathematics achievement: An eight-year longitudinal study. *Journal of Educational Psychology*, 109, 680–693. <https://doi.org/10.1037/edu0000159>.
- Powell, S. R., Fuchs, L. S., & Fuchs, D. (2013). Reaching the mountaintop: Addressing the common core standards in mathematics for students with mathematics difficulties. *Learning Disabilities Research & Practice*, 28, 38–48.
- Linder, S. M., and A. Simpson. 2017. "Towards an Understanding of Early Childhood Mathematics Education: A Systematic Review of the Literature Focusing on Practicing and Prospective Teachers." *Contemporary Issues in Early Childhood*. doi:10.1177/1463949117719553.
- Tinto, P. P., Shelly, B. A., & Zarach, N. J. (1994). Connecting research to teaching: Classroom research and classroom practice: Blurring the boundaries. *The mathematics teacher*, 87(8), 644-648.
- Basori, E. R. (2018). Pengaruh Pembelajaran Matematika Realistik terhadap Kemampuan Berhitung Anak Tunagrahita Ringan Kelas 1 di SD Inklusi Glagahwero 01. *Journal of Special Education*, I(2), 1–4. Retrieved from <https://jurnal.ikipjember.ac.id/index.php/speed/article/download/19/27>
- Dessy, G., Lostari, S., Wahyuno, E., & Irianto, T. (2003). Realistik Indonesia Terhadap Hasil Belajar Matematika Anak Tunagrahita.
- Kamisah, O., Zanaton, I., & Lilia, H. (2013). Penerapan Media Permainan Puzzle Untuk Meningkatkan Hasil Belajar Matematika Anak Tunagrahita Ringan Kelas 1 di SLB/ C TPA Jember. *Jurnal Pendidikan*.