25 (2), 2024, 701-711
Jurnal Pendidikan MIPA
e-ISSN: 2685-5488 | p-ISSN: 1411-2531
http://jurnal.fkip.unila.ac.id/index.php/jpmipa/

A Systematic Literature Review: Generalization in Solving Number Pattern Problems

Nyla Farhatul Maula, Didi Suryadi*, & Al Jupri
Department of Mathematic Education, Universitas Pendidikan Indonesia, Indonesia

Abstract: Generalization is the process of identifying common characteristics in mental objects to find patterns, allowing for the application of general rules. It plays a crucial role in mathematics, being a fundamental aspect of mathematical thinking. Generalization is closely related to number patterns because number patterns can naturally lead to general expressions in generalizations. This study aims to review research on generalizations in number pattern material from 2004 to 2024. The research method uses a Systematic Literature Review which collects primary data that has been published in Sinta and Scopus-indexed journals. Data extraction is adjusted to the selection criteria so that 18 articles are collected. Data analysis follows a qualitative approach. Data grouping was carried out based on year of publication, level of education, research subject, journal index, demographics, methods, and generalization topics analyzed. Results show that 2015 and 2023 were key years for publications on this topic in reputable national and international journals. Researchers tend to focus on generalizations in number pattern problems at the junior high school level. Most studies use qualitative methods, exploring generalization strategies, representations, and processes.

Keywords: generalization, number pattern, systematic literature review, mathematics, education.

▪ INTRODUCTION

Generalization is the recognition of several common characteristics in a set of mental objects (Dreyfus, 1991). Generalization is also defined as the process of finding similarities or patterns in each example or case, so that they can be applied generally for regularity (Brief, 2003). The introduction of these common characteristics generalizes a component for finding general formulas where students can find formulas to become the next pattern (Moguel, Landa, & Sachnex, 2019). Through generalizations, students are involved in expanding the range of reasoning or communication to enrich the cognitive structure in students' minds because there are activities that connect them (Kaput, 1999).

Generalization is crucial in mathematics because generalization has a role in helping students to close the gap between previous knowledge and new ideas then make connections from previous knowledge to reach new concepts (Stacey, 1989). Furthermore, generalization plays an important role in mathematics because it is considered inherent in mathematical thinking in general (Dindyal, 2017; Barbosa & Vale, 2015). Consideration of the important role of generalization in mathematics is not only because generalization is inherent in mathematical thinking, more than that, generalization is said to be the main goal in learning mathematics (Barbosa, et al., 2015). Barbosa and Vale (2015) added that generalization plays an important role in mathematical activities this is considered a general mathematical thinking ability.

This description leads to the conclusion that generalization is an important aspect of mathematics with various considerations. The important role of generalization in mathematics has led several researchers to conduct research on this topic. From several studies it was found that generalization is recognized as an important component of

Didi Suryadi
*Email: didisuryadi@upi.edu

DOI: http://dx.doi.org/10.23960/jpmipa/v25i2.pp701-711
Received: 05 September 2024
Accepted: 24 September 2024
Published: 27 September 2024

mathematical activities but it is still difficult for students to do it successfully and for teachers to support it effectively (Jurow, 2004; Lannin, 2005; Mason, 1996).

Research on generalization often explores various mathematical topics. Number patterns are the most frequently researched material regarding generalization (Dindyal, 2007; Fadiana, 2018; Guner et al., 2013; Kusumaningtyas et al., 2017; Somasundram et al., 2019; Yilzid & Durmaz, 2021). This is because every process passed in generalization allows for the use of relationships in number patterns (Lannin, 2005; Zazkis & Liljedahl, 2002). Number patterns have been linked to the process of generalization, given that they can naturally lead to general expressions. Each process passed in generalization allows the use of relationships in patterns to make predictions about the next pattern (Lannin, 2005; Zazkis & Liljedahl, 2002).

The pattern referred to in this generalization is a regularity that can be in the form of numerical, spatial, or logical relationships (Mulligan & Mitchelmore, 2009). They are closely linked to various mathematical domains, including numbers, algebra, geometry, measurement, and probability—areas identified as core content standards in mathematics education by the National Council of Teachers of Mathematics (NCTM) (Tikekar, 2009). The study of number patterns, therefore, holds a strategic position in the teaching and learning of mathematics at both elementary and secondary school levels (Rusmawati, 2021). Almost all mathematics is based on patterns, and abstracting these patterns is the goal of mathematics learning (Mulligan & Mitchelmore, 2009; Warren, 2005).

Despite the importance of number patterns in mathematics learning, errors and learning obstacles frequently arise when students encounter this material. This has been explained in several recent studies. Some of these errors are unable to recognize the pattern that is formed and inability to communicate or express the patterns that have been obtained. The results of the analysis carried out showed that the subjects were unable to identify patterns formed from the problems presented (Fauzi & Masduki, 2022; Jelahu et al., 2023). There is previous research which reveals that students experience difficulty when expressing patterns that have been found in mathematical form (Spangenberg & Pithmajor, 2020).

Considering the importance of generalization and the relationship between number patterns, research on generalization in mathematics, especially in number patterns, has developed in several specific topics. Amit & Neria (2007) emphasized that generalization of number patterns is the foundation of students' algebraic thinking, with recursive and explicit strategies helping in making local and global generalizations. Akkan (2013) added that although recursive strategies are used more often, students' generalization abilities increase with increasing grade level, especially in linear patterns compared to quadratic. Firdaus (2022) found that visual learning styles facilitate students in processing information better than auditory and kinesthetic, making them more effective in pattern generalization.

Although many studies have explored the concept of generalization in mathematics, a comprehensive review specifically focused on the generalization of number pattern problems has yet to be conducted. Previous reviews, such as Suwanto's (2018) systematic literature review, examined the existing literature on mathematical generalization and emphasized the importance of this process in mathematics learning. The study categorized mathematical generalization into two main aspects, namely the generalization process and the generalization product, which cover various mathematical topics such as numeracy, algebra, and statistics. However, this study emphasized that mathematical generalization is often studied in general without a specific focus on certain materials or topics. Generalization of number patterns is one of the basic concepts in mathematics, but this study did not provide an in-depth exploration of how students understand and generalize number patterns specifically.

There is a research gap related to generalization of number patterns in students at various levels of education. SLR research that focuses on generalization of number pattern material can fill this gap and provide a more specific understanding of the learning methods and challenges faced by students in generalizing number patterns.

Given the various approaches and challenges identified in previous studies, there is a clear need for a comprehensive review. A comprehensive review that specifically focuses on generalization of number pattern problems has not been conducted. A Systematic Literature Review (SLR) would help summarize existing findings and provide clearer guidance on how to support students in understanding and generalizing number patterns effectively. From the various studies that have been conducted in recent years, a comprehensive review of generalization in solving number pattern materials is needed to see research related to trends in this topic.

The researcher conducted this study to describe the results of research on generalization in solving number pattern problems in articles published in 2005-2024 obtained from the Google Scholar, Semantic Scholar, and ERIC databases. This study uses the Systematic Literature Review (SLR) method. The SLR research method aims to collect and synthesize comprehensive research data based on specific questions, organized, transparent and replicable procedures at each step of the process (Kek & Huijser, 2011; Juandi & Tamur, 2021). The SLR method allows for a more objective assessment of evidence than traditional narrative reviews and can contribute to resolving uncertainties and identifying areas requiring further study (Egger et al., 2009).

▪ METHOD

Research Design

The research design used in this study is Systematic Literature Review (SLR), where this method is carried out by synthesizing the results of scientific studies to answer certain research questions in a transparent and reproducible manner (Lame, 2019). This study focuses on studies related to mathematical generalization, especially on number patterns.

Search Strategy

The search strategy was conducted through the use of relevant keywords such as "generalization," "number patterns," and "mathematics education" to ensure that the research searched was related to this topic. The search process was conducted in the Google Scholar, Semantic Scholar, and ERIC databases, with articles selected only from journals indexed by Sinta and Scopus. Initial screening was conducted to identify studies that were appropriate to the context of this study. At this stage, 29 initial studies were generated, which were then further screened based on the inclusion and exclusion criteria set.

Inclusion and Exclusion Criteria

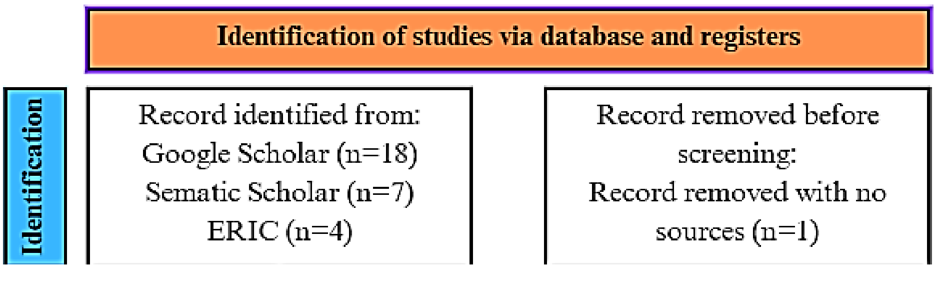
The population in this study is all studies about generalization in solving number pattern problems. The studies collected amounted to 29 studies. The sample for this research was carefully selected based on the inclusion criteria. The inclusion criteria applied in this study are as follows: (a) Research in the field of mathematics education; (b) Studies that focus on generalization in solving number pattern problems; (c) Research at the elementary, secondary, and tertiary education levels; (d) Research published in the last 20 years (2005-2024); and (e) Articles published in journals indexed by Sinta and Scopus. After the selection process, out of 29 articles, 16 articles were selected based on these criteria.

Data Analysis

A descriptive qualitative data analysis approach was used to interpret the results from the selected studies. The analysis followed four steps. First, reading and understanding the entire content of each article. The researcher thoroughly reviewed each selected study to gain a deep understanding of its findings and relevance. Second, summarizing the findings from each article. Each study's key findings were summarized, with a focus on how generalization was approached in the context of solving number pattern problems. Third, relating the findings to identify common themes. The researcher compared the findings of different studies to identify common themes, trends, or gaps across the research. Fourth, drawing conclusions based on the synthesized findings. The final step involved drawing comprehensive conclusions about the generalization process in solving number pattern problems, including identifying areas that require further research or practical application.

▪ RESULT AND DISSCUSSION

There are three stages of research article selection using the PRISMA flowchart. Figure 1 shows the PRISMA flowchart that illustrates the study screening process in a systematic review. This process begins with the identification of records retrieved from various sources, namely Google Scholar (n=18), Sematic Scholar (n=7), and ERIC (n=4). A total of 1 record was removed before screening because it did not have a source. The next stage is screening, where existing records are screened and some studies are excluded because they require more in-depth screening. Relevant reports are then searched for retrieval, but some reports cannot be obtained. Furthermore, the retrieved reports are assessed for eligibility, and 5 reports are excluded because they do not meet the criteria of the CASP (Critical Appraisal Skills Programme) Checklist. Ultimately, a total of 16 research reports were successfully included in this systematic review after passing all stages of screening and assessment. This diagram shows the study selection flow from identification to final selection, ensuring that only quality and relevant studies are included in the review.



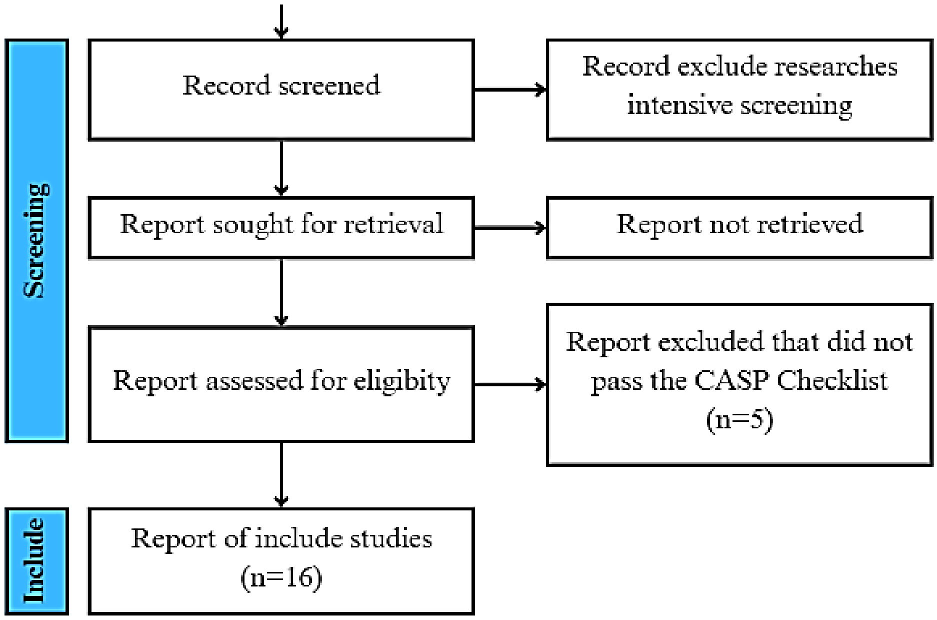


Figure 1. Search strategy using PRISMA

Tabel 1. Studies highlighting generalization in solving number pattern problems

No	Title	Generalization in Solving Number Pattern Problems
1	A Learning Trajectory in 6-Year-Olds' Thinking About Generalizing Functional Relationships	- Children as young as 6 years old are able to recognize and generalize functional relationships in repeating patterns. - The main challenge is the difficulty in representing mathematical relationships symbolically. - Children at a young age have a deeper understanding of patterns than expected.
2	Comparison of 6th-8th Graders' Efficiencies, Strategies and Representations Regarding Generalization Patterns	- Students in grades 6-8 use recursive strategies more often in solving linear patterns. - Students have difficulty generalizing quadratic patterns because they focus on the differences between the nearest terms. - Generalization skills increase with grade level.
3	A Gifted High School Student's Generalization Strategies of Linear and Nonlinear Patterns via Gauss's Approach	- Gifted students find it easier to generalize linear patterns using figural reasoning. - Gauss's approach helps simplify the generalization of non-linear patterns. - The main challenge is students' difficulty in finding common patterns in non-linear patterns.
4	Visual templates in pattern generalization activity	- Visual templates help students build algebraic structures from figural patterns. - Difficulties occur with non-linear patterns with complex structures. - With linear patterns, simple visual templates are more successful in helping generalization.

5	‘‘Rising to the challenge’’: using generalization in pattern problems to unearth the algebraic skills of talented pre-algebra students	- Students use both recursive-local and functional-global approaches in pattern generalization. - The main challenge occurs when students switch from a recursive to a functional approach to non-linear patterns. - The reflection process is important to ensure the consistency of the generalizations made.
6	*Profil Generalisasi Berdasarkan Perspektif Semiotik Siswa Operasional Konkret dan Operasional Formal*	- Concrete students observe patterns, formal students calculate patterns. - Concrete students struggle with variables, formal students generate formulas. - Main challenge: concrete students cannot validate formulas.
7	*Penalaran Generalisasi Siswa SMP alam Memecahkan Masalah ada Materi Barisan Bilangan Ditinjau Berdasarkan Tipe Kepribadian*	- Generalization reasoning is important in mathematics - Personality influences how students generalize - Choleric and sanguine are quick but less accurate, phlegmatic and melancholic are more careful.
8	The Influence of Reasoning with Emergent Quantities on Students' Generalizations	- Comparing number pattern generalization strategies and quantitative relationships. - Quantitative reasoning is stronger in generalization. - Students who focus on number patterns tend to be less explicit.
9	*Kemampuan Generalisasi Matematis Ditinjau dari Gaya Kognitif Siswa SMP*	- Field independent students are more independent in generalization. - Field dependent students need external assistance. - Field independents are better at formulating, dependents are better at being assisted.
10	*Proses berpikir dalam menggeneralisasi pola bilangan berdasarkan gaya belajar pada siswa kelas VIII SMP*	- Visual learners are better at retaining information. - Visual and kinesthetic learners excel at finding additional information. - Auditory learners have difficulty concluding, visual learners are more precise.
11	*Analisis strategi siswa sekolah dasar dalam memecahkan masalah generalisasi pola ditinjau dari gaya kognitif*	- Field independent students are more analytical and stable in solving numerical and symbolic patterns. - Field dependent students need visual aids or tables to understand and verify patterns. - Field independents maintain strategies, while field dependents are more influenced by context.
12	The Distributed Nature of Pattern Generalization	- Pattern generalization is influenced by cognitive and sociocultural factors. - The cognitive shift from recursive to functional affects the understanding of algebraic structures. - The main challenge is to get students to see functional patterns, not just recursive calculations.
13	*Pemecahan Masalah Generalisasi Pola Siswa Kelas VII SMP Ditinjau Dari Gaya Kognitif Field*	- FI students are more analytical in solving number patterns and using mathematical notation.

	Independendt Dan Field Dependent	- FD students rely more on visual and recursive patterns, having difficulty in determining the nth term. - FI successfully uses explicit rules to find the nth term, FD tends to have difficulty planning long-term solutions.
14	*Proses Generalisasi Pola Bilangan Siswa SMP dalam Memecahkan Masalah Matematika Berdasarkan Gaya Belajar*	- Visual learners are better at recognizing and writing down complete patterns. - Auditory learners are often distracted and do not write down their understanding completely. - Kinesthetic learners are more intuitive, but often overlook problem-solving steps.
15	*Analisis Kesalahan Konseptual dan Prosedural Siswa Sekolah Dasar Dalam Menggeneralisasi Pola Bilangan*	- Low problem-solving students often make conceptual errors in mathematical operations. - Medium problem-solving students are less careful in calculating and writing algebraic patterns. - High problem-solving students generally make procedural errors in constructing patterns.
16	*Conjecturing dalam Pemecahan Masalah Generalisasi Pola*	- Conjecturing is the process of formulating an unverified hypothesis in solving a pattern. - The conjecturing process involves observation, formulation, validation, and generalization. - Students often have difficulty formulating and validating conjectures, especially in more complex patterns.

The sixteen included studies were derived from articles in Sinta and Scopus indexed journals. Generalizations on number patterns from the 16 studies are described as shown in Table 1 which were analyzed using a thematic analysis approach. The results of the thematic analysis produced five themes, namely: (1) errors in generalizing number patterns; (2) generalizations based on learning and cognitive styles; (3) generalizations based on personality types: (4) generalization strategies and mathematical approaches; and (5) the influence of using visual representations and technological aids.

Theme 1. Errors in Generalizing Number Patterns

Conceptual and procedural errors often occur when students face number pattern problems. Mega (2021) revealed that students with low problem-solving abilities are more likely to make conceptual errors, such as misunderstanding mathematical operations or algebraic expressions. Meanwhile, students with high abilities more often make procedural errors in applying the solution steps. Amy Ellis (2007) added that students who focus only on number patterns are often unable to identify deeper quantitative relationships, which hinders their ability to make explicit generalizations. These errors indicate the importance of balanced teaching between procedural and conceptual.

Theme 2. Generalizations Based on Learning and Cognitive Styles

Various learning and cognitive styles greatly influence the process of generalizing number patterns. Nirfayanti (2023) stated that students with a field independent cognitive style are superior in formulating generalizations symbolically, while field dependent students need external assistance such as teacher guidance or peers to understand patterns. Andi Firdaus (2022) found that students with a visual learning style tend to be better at recognizing and arranging patterns structurally than students with an auditory or kinesthetic learning style. Kusumaningtiyas (2017) added that students with a field-independent cognitive style are more analytical and succeed in solving number patterns with an explicit approach, while field-dependent students rely more on visual representations and often have difficulty in determining global patterns. These results indicate that the teaching approach must be adjusted to the cognitive style and learning style of students so that the generalization process can run optimally.

Theme 3. Generalizations Based on Personality Types

Personality plays a role in how students generalize number pattern problems. Endah (2018) explains that students with choleric personalities tend to be quick in making decisions but often make mistakes, especially if the pattern is not clearly visible. On the other hand, students with melancholic personalities are more thorough and analytical, although they take longer to solve problems. Phlegmatic and sanguine show unique characteristics in processing information and facing challenges, where sanguine students tend to give up when faced with difficulties, while phlegmatic students choose easier solutions even though the results are less than perfect.

Theme 4. Generalization Strategies and Mathematical Approaches

In the generalization process, the strategies used by students greatly determine their success. Yassar (2013) compared the use of recursive and explicit strategies in students in grades 6 to 8. Students were more likely to use recursive strategies, especially for linear patterns, although explicit strategies were more effective in more complex patterns. Yildiz (2021) studied gifted students who used the Gaussian approach in generalizing linear and non-linear patterns. This approach allowed gifted students to overcome challenges in more complex patterns. Rivera (2009) added that the use of visual templates helps students in generalizing figurative patterns, especially in non-linear patterns, although some students have difficulty applying visual templates to less structured patterns. Sutarto (2015) highlighted the importance of guessing in generalization, where students make initial guesses, validate them, and finally build generalizations. This process is often non-linear, and students often have to go back to previous steps to refine their guesses.

Theme 5. The Influence of Using Visual Representations and Technological Aids

The use of visual representations and technology, such as graphing calculators, plays a significant role in helping students understand and generalize number patterns. Rivera (2015) suggests that pattern generalization is influenced not only by cognitive abilities but also by social and class factors. The use of technology such as graphing calculators helps students better visualize patterns and shift from recursive to functional strategies. Barbosa (2015) notes that children as young as six are able to understand functional relationships through the use of figurative and numerical representations, which were previously considered too abstract for their age. Miriam Amit (2007) also highlights that gifted students in mathematics are able to switch between recursive and functional strategies, especially in non-linear patterns, although challenges in moving from one strategy to the other remain.

▪ CONCLUSION

In conclusion, this study uses the Systematic Literature Review (SLR) method by synthesizing 16 studies from journals indexed by Sinta and Scopus to answer questions related to the generalization of number patterns in mathematics learning. Through thematic analysis, this study produced five main themes: (1) errors in the generalization of number patterns including conceptual and procedural errors, (2) the influence of learning styles and cognition on the generalization process, (3) the role of personality type in decision making when generalizing patterns, (4) generalization strategies and effective mathematical approaches in solving number pattern problems, and (5) the influence of visual representation and technology in helping students understand and generalize patterns. The results of the study indicate that balanced learning between conceptual and procedural knowledge, as well as the use of technology and visual representation, is very important in improving students' ability to generalize number patterns.

▪ REFERENCES

Barbosa, A. & Vale, I. (2015). Visualization in pattern generalization: potential and challenges. Journal of the European Teacher Education Network, 10(3), 57–70

Breger, H. (2000). Tacit Knowledge and Mathematical Progress. In: Grosholz, E., Breger, H. (eds) The growth of mathematical knowledge. Synthese Library (289). Dordrecht : Springer. https://doi.org/10.1007/978-94-015-9558-2_15

De-chen, Z. (2014). Teacher as Researcher: Analysis Based on Lesson Study

Dindyal, J. (2007). High school students' use of patterns and generalisations. Proceedings of the 30th Annual Conferences of the Mathematics Education Research Group of Australasia (236-245). Australia: Merga Inc

Dreyfus, T. (1991). Advanced mathematical thinking processes. in d. tall (ed.), advanced mathematical thinking (25-41). Boston: Kluwer Academic Publishers

Egger, M., Davey Smith, G., & Sterne, J. (2009). 623 Systematic reviews and meta-analysis. In R. Detels, R. Beaglehole, M. A. Lansang, & M. Gulliford (Eds.), Oxford Textbook of Public Health (p. 0). Oxford University Press. https://doi.org/10.1093/med/9780199218707.003.0039

Ellis, A. B (2007). The influence of reasoning with emergent quantities on students' generalization. Cognitive and Instruction, 25(4), 439-478. http://www.jstor.org/stable/27739866

Fauzi, A. H. N., & Masduki, M. (2022). Student's anomaly reasoning in solving number pattern in terms of gender. Jurnal Didaktik Matematika, 9(2), 328–342. https://doi.org/10.24815/jdm.v9i2.27146

Firdaus, A. N., Juniati, D., Wijayanti. P. (2020). Number pattern generalization process by provincial mathematics olympiad winner students. Journal for The Education of Gifted Young Scientists, 8(3), 991-1003. http://dx.doi.org/10.17478/jegys.70498

Guzman, A.C., Marino, C.A., Arocha, I.C., Torga, E.P., Arocha, A.C., Gattorno, Y.R., Perez, J.E., Almeida, J.C., & Pérez, M.P. (2015). La investigación cualitativa. Anais Brasileiros De Dermatologia, 20, 262-265.

Hariyomurti, B., Prabawanto, S., & Jupri, A. (2020). *Hambatan belajar siswa dalam pembelajaran barisan dan deret aritmetika.* Journal for Research in Mathematics Learning, 3(3), 283. https://doi.org/10.24014/juring.v3i3.10118

Jelahu, R. A., Son, A. L., Bete, H., Garcia, J., Sudirman, S., & Alghadari, F. (2023). Profile of middle school students' mathematical literacy ability in solving number pattern problems. International Journal of Science Education and Cultural Studies, 2(1), 1–14. https://doi.org/10.58291/ijsecs.v2i1.72

Juandi, D., & Tamur, M. (2021). The impact of problem-based learning toward enhancing mathematical thinking: a meta-analysis study. Journal of Engineering Science and Technology, 16(4), 3548– 3561

Kek, M.Y.C.A.; and Huijser, H. (2011). The power of problem-based learning in developing critical thinking skills: preparing students for tomorrow's digital futures in today's classrooms. Higher Education Research and Development, 30(2011), 329-341. https://doi.org/10.1080/07294360.2010.501074

Kirwan, J. V. (2015). Preservice secondary mathematics teachers' knowledge of generalization and justification on geometric-numerical patterning tasks. doctor of philosophy dissertation. Department of Mathematics Illinois State University. http://doi.org/10.30707/ETD2015.Kirwan.J

Lame, G. (2019). Systematic literature reviews: an introduction. proceedings of the international conference on engineering Design, ICED, 2019-Augus(July), 1633–1642. https://doi.org/10.1017/dsi.2019.169

Lannin, J. K. (2005). Generalization and justification: the challenge of introducing algebraic reasoning through patterning activities. Mathematical Thinking and Learning, 7(3), 231-258. https://doi.org/10.1207/s15327833mtl0703_3

Li, M. (2019). Teacher learning research: a critical overview. in: understanding the impact of INSET on teacher change in China. Singapore: Palgrave Pivot. https://doi.org/10.1007/978-981-13-3311-8_3

Marbawi, M. I., & Salim, T. A. (2019). *Mempertahankan keaslian arsip elektronik di era digital berdasarkan tinjauan literatur sistematis.* Berkala Ilmu Perpustakaan Dan Informasi, 15(2), 149. https://doi.org/10.22146/bip.47370

Mayer, J. M., Huntley, M. A., Fonger, N. L., & Terrell, M. S. (2019). Professional learning through teacher-researcher collaborations. The Mathematics Teacher, 112 (5). https://doi.org/10.5951/mathteacher.112.5.0382.

Moguel, S. L. E., Landa, A. E., & Sanchez, C.G. (2019). Characterization of inductive reasoning in middle school mathematics teachers in a generalization task. International Electronic Journal of Mathematics Education, 14(3), 563–581. https://doi.org/10.29333/iejme/5769

Mulligan, J., & Mitchelmore, M. (2009). Awareness of pattern and structure in early mathematical development. Mathematics Education Research Journal, 21(2), 33–49. https://doi.org/10.1007/BF03217544

Rusmawati, K. L. (2021). Analysis of student learning difficulties on number pattern material reviewed from student learning independence. Mathematics Education Journals, 5 (2), 132-144. https://doi.org/10.22219/mej.v5i2.17089

Sari, P. I., & Yudha, R. I. (2022). Developing individual students through changes of thinking pattern and self perception on learning activities. Al-Ishlah-Jurnal Pendidikan, 14(4), 4891-4898. https://doi.org/10.35445/alishlah.v14i4.1685

Spangenberg, E. D., & Pithmajor, A. K. (2020). Grade 9 mathematics learners' strategies in solving number-pattern problems. Eurasia Journal of Mathematics, Science and Technology Education, 16(7). https://doi.org/10.29333/EJMSTE/8252

Stapic, Z., López, E. G., Cabot, A. G., de Marcos Ortega, L., & Strahonja, V. (2012). Performing systematic literature review in software engineering. In Central European Conference on Information and Intelligent Systems (p. 441). Faculty of Organization and Informatics Varazdin.

Tikekar, V. G. (2009). Deceptive patterns in mathematics. International Journal of Mathematical Science Education, 2(1), 13–21

Ulla, M. B., Barrera, K. B., & Acompanado, M. M. (2017). Philippine classroom teachers as researchers: teachers' perceptions, motivations, and challenges. Australian Journal of Teacher Education, 42(11). https://doi.org/10.14221/ajte.2017v42n11.4

Vikal, J. K. (2017). A Comparative account of qualitative and quantitative research. Learning Community-An International Journal of Education and Social Development, 8(3), 113-118. http://dx.doi.org/10.5958/2231-458X.2017.00016.1

Zazkis, R., & Liljedahl, P. (2002). Generalization of patterns: the tension between algebraic thinking and algebraic notation. Educational Studies in Mathematics, 49, 379-402. https://doi.org/10.1023/A:1020291317178