EKSPLORASI PROSES BERPIKIR SISWA SMP DALAM MEMECAHKAN MASALAH ALJABAR DITINJAU DARI ASPEK REPRESENTASI SEMIOTIK MATEMATIS

DISERTASI

Diajukan untuk memenuhi sebagian syarat untuk memperoleh gelar
Doktor Pendidikan Matematika

Oleh

WA ODE DAHIANA
NIM 1803375

PROGRAM STUDI PENDIDIKAN MATEMATIKA

FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM

UNIVERSITAS PENDIDIKAN INDONESIA

2024

EKSPLORASI PROSES BERPIKIR SISWA SMP DALAM MEMECAHKAN MASALAH ALJABAR DITINJAU DARI ASPEK REPRESENTASI SEMIOTIK MATEMATIS

Oleh
Wa Ode Dahiana

S.Pd. Universitas Pattimura, 2004
M.Pd. Universitas Pendidikan Indonesia 2010

Sebuah Disertasi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Doktor Pendidikan (Dr.) pada Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

Universitas Pendidikan Indonesia
Agustus 2024

LEMBAR PENGESAHAN DISERTASI

WA ODE DAHIANA

EKSPLORASI PROSES BERPIKIR SISWA SMP DALAM MEMECAHKAN MASALAH ALJABAR DITINJAU DARI ASPEK REPRESENTASI SEMIOTIK MATEMATIS

Disetujui dan Disahkan oleh Tim Panitia Disertasi

Prof. Dr. H. Tatang Herman, M.Ed.
Promotor Merangkap Ketua

Dr. Elah Nurlaelah, M.Si
Ko-Promotor

Prof. Turmudi, M.Ed., M.Sc., Ph.D
Anggota Penguji

Dr. Jarnawi Afgani Dahlan, M.Kes.
Anggota Penguji

Prof. Dr. Hamzah Upu, M.Ed.
Penguji Luar Universitas

Mengetahui,
Ketua Program Studi Pendidikan Matematika
FPMIPA Universitas Pendidikan Indonesia

Prof. Al Jupri, S.Pd. M.Sc. Ph.D
NIP. 19820510 200501 1 002

ABSTRAK

Wa Ode Dahiana (2024) Eksplorasi proses berpikir siswa SMP dalam memecahkan masalah aljabar ditinjau dari aspek representasi semiotik matematis

Pemecahan masalah merupakan suatu cara dan sarana pembelajaran matematika. Ini mencakup interpretasi, memodelkan, menghubungkan, mengkomunikasikan, dan memahami ide dan konsep matematika. Meskipun banyak cara untuk mendukung analisis pemecahan masalah matematis siswa telah diidentifikasi dalam literatur, hanya ada sedikit yang menggunakan representasi semiotik matematis dan proses berpikir (Ways of Thinking). Oleh karena itu, tujuan penelitian ini adalah untuk mendeskripsikan secara komprehensif dan memperoleh teori substantif (konjektur) tentang keterampilan representasi semiotik matematis dan *Ways of Thinking* (WoT) dalam pemecahan masalah aljabar berdasarkan level kemampuan matematis. Untuk mencapai tujuan ini, peneliti melakukan penelitian kualitatif dengan metode *grounded theory* melalui tiga langkah berikut. Pertama, setelah melakukan kajian literatur, peneliti mendesain soal-soal terapan aljabar untuk mengukur keterampilan representasi semiotik matematis siswa. Kedua, peneliti memberikan tes individu tertulis terhadap 31 siswa kelas XI (usia 16-17 tahun) dan melakukan wawancara mendalam dengan 13 partisipan yang dipilih berdasarkan level kemampuan matematis. Ketiga, hasil tes dan transkrip wawancara dianalisis menggunakan *software Nvivo 12 plus*. Hasil analisis menunjukkan bahwa siswa kelompok *high ability* mampu menunjukkan hampir semua aspek indikator keterampilan representasi semiotik matematis serta memiliki *WoT* invarian aljabar, penalaran proporsional dan deduktif; kelompok *middle ability* mampu menunjukkan masing-masing sebagian dari aspek indikator keterampilan representasi semiotik matematis serta cenderung memiliki *WoT* invarian aljabar, penalaran proporsional dan deduktif; kelompok *low ability* hanya menunjukkan satu aspek indikator keterampilan representasi semiotik matematis serta memiliki *WoT* simbolik *non-referensial*. Sementara, analisis *grounded theory* menghasilkan rumusan teoritik yakni semakin tinggi level kemampuan matematis siswa, semakin baik penguasaan mereka terhadap aspek keterampilan representasi semiotik yang dibutuhkan dalam pemecahan masalah aljabar serta semakin baik pula *WoT* yang dimilikinya. Temuan ini menyimpulkan bahwa keterampilan representasi semiotik matematis dan *WoT* menentukan kinerja siswa dalam memecahkan masalah aljabar.

Kata kunci: Keterampilan representasi semiotik, *ways of thinking*, pemecahan masalah aljabar, pendekatan *grounded theory*.

ABSTRACT

Wa Ode Dahiana (2024) Exploration of junior high school students' thought process in solving algebraic problems in terms of semiotic mathematical representations

Problem solving is a way and medium of learning mathematics. It includes interpreting, modeling, connecting, communicating, and understanding mathematical ideas and concepts. Although many ways to support students' mathematical problem-solving analysis have been identified in the literature, there are only a few that use mathematical semiotic representations and ways of thinking. Therefore, the purpose of this study is to comprehensively describe and derive substantive theories (conjectures) about mathematical semiotic representation skills and Ways of Thinking (WoT) in algebraic problem solving based on mathematical ability levels. To achieve this goal, the researcher conducted qualitative research with the grounded theory method through the following three steps. First, after conducting a literature review, the researcher designed applied algebra problems to measure students' mathematical semiotic representation skills. Second, the researcher administered individual written tests to 31 students in grade XI (aged 16-17 years) and conducted in-depth interviews with 13 participants selected based on mathematical ability level. Third, the test results and interview transcripts were analyzed using Nvivo 12 plus software. The results of the analysis showed that the high ability group students were able to show almost all aspects of the indicators of mathematical semiotic representation skills and had WoT of algebraic invariants, proportional and deductive reasoning; the middle ability group was able to show each part of the aspects of the indicators of mathematical semiotic representation skills and tended to have WoT of algebraic invariants, proportional and deductive reasoning; the low ability group only showed one aspect of the indicators of mathematical semiotic representation skills and had non-referential symbolic WoT. Meanwhile, the grounded theory analysis resulted in a theoretical formulation that the higher the level of students' mathematical ability, the better their mastery of the aspects of semiotic representation skills needed in solving algebra problems and the better their WoT. The findings conclude that mathematical semiotic representation skills and WoT determine students' performance in solving algebraic problems.

Keywords: Semiotic representation skills, ways of thinking, algebra problem solving, grounded theory approach.

DAFTAR ISI

DAFTAR TABEL

DAFTAR GAMBAR

DAFTAR LAMPIRAN

DAFTAR PUSTAKA

Absorin, A., dan Sugiman, S. (2018). Eksplorasi kemampuan penalaran dan representasi matematis siswa sekolah menengah pertama. *Pythagoras : Jurnal Pendidikan Matematika*, *13(2)*, 189–202. https://doi.org/10.21831/pg.v13i2.21249

Ainley, J., Bagni, G. T., Hefendehl–Hebeker, L., & Lagrange, J. (2010). Algebraic Thinking and Mathematics Education. *Working Group 4*, *Proceedings of cerme 6*, 415–419. www.inrp.fr/editions/cerme6

Anderson, J. R. (2010). Cognitive Psychology an Its Implications seventh edition (S. Edition (ed.)). Worth Publishers.

Antony J. Puddephatt. (2007). *Special: An Interview with Kathy Charmaz: II*(3). https://doi.org/10.18778/1733-8077.2.3.02 Special:

Apriza, B. (2019). Kemampuan berpikir kritis melalui pembelajaran matematika dengan problem based learning. *Eksponen*, *9*, 55–66.

Arshad, Y., Ahlan, A. R., & Syed Ibrahim, S. N. (2013). Combining grounded theory and case study methods in IT \r\noutsourcing study. *Journal of Information Systems Research and Innovation*, *August*, 84–93. http://irep.iium.edu.my/32105/2/Pub10_GroundedTheoryCaseStudy.pdf

Attridge, N. (2013). *Advanced mathematics and deductive reasoning skills : testing the Theory of Formal Discipline*.

Báez, A. M., Pérez-González, O. L., & Triana-Hernández, B. (2017). Propuesta didáctica basada en múltiples formas de representación semiótica de los objetos matemáticos para desarrollar el proceso de enseñanza aprendizaje del cálculo diferencial. *Academia y Virtualidad*, *10*(2), 20–30. https://doi.org/10.18359/ravi.2743

Banks, J. A. (2000). An Introduction to Multicultural Counselling. In *Mental Health Practice* (Vol. 3, Issue 5). https://doi.org/10.7748/mhp.3.5.37.s20

Bassoi, T. (2006). *Representações do objeto matemático funções em aulas do ensino fundamental* [Universidade Federal do Paraná]. http://www.educadores.diaadia.pr.gov.br/arquivos/File/2010/artigos_teses/matematica/Tese_Bassoi.pdf

Bergeron, D. A., & Gaboury, I. (2020). Challenges related to the analytical process in realist evaluation and latest developments on the use of NVivo from a realist perspective. *International Journal of Social Research Methodology*, *23*(3), 355–365. https://doi.org/10.1080/13645579.2019.1697167

Bittar, E. C. B. (2021). *Semiotics, law & art* in S. Marusek, A. Wagner, & E. C. B. Bittar (eds.). Springer.

Booker, G. (2009). Algebraic Thinking: Generalizing Number and Geometry to Express Patterns and Properties Succinctly. *Griffith University: Mathematical of*

Prime Importance, 10–21.
Breiteig, T., & Grevholm, B. (2006). The transition from arithmetic to algebra: To Reason, Explain, Argue, Generalize and Justify. *Proceedings of the 30th Conference of the International Group for the Psychology of Mathematics Education*, *2*, 225–232.
Brodie, K. (2010). Teaching mathematical reasoning in secondary school school classrooms. Springer.
Cai, J., Lew, H. C., Morris, A., Moyer, J. C., Fong Ng, S., & Schmittau, J. (2005). The development of students' algebraic thinking in earlier grades: *Zentralblatt Für Didaktik Der Mathematik*, *37*(1), 5–15. https://doi.org/10.1007/bf02655892
Carraher, Schliemann, & B. (2006). *Arithmetic and Algebra in Early*. *March*. https://doi.org/10.2307/30034843
Carraher, D. W., Schliemann, A. D., Brizuela, B. M., & Earnest, D. (2006). Arithmetic and algebra in early mathematics education. *Journal for Research in Mathematics Education*, *37*(2), 87–115. https://doi.org/10.2307/30034843
Casey, D., & Murphy, K. (2009). Issues in using methodological triangulation in research. Nurse Researcher.
Chairunnisak. (2020). Implementasi Pembelajaran Abad 21 Di Indonesia. *Prosiding Seminar Nasional Teknologi Pendidikan Pascasarjana UNIMED*, 351–359.
Charmaz, K. (2000). Grounded theory: Objectivist and contructivist methods. In N. K. Denzin & Y. Lincoln. (Eds.), *The Handbook of Qualitative Research*. Sage Publications.
Chimmalee, B., & Anupan, A. (2022). Effect of Model-Eliciting Activities using Cloud Technology on the Mathematical Problem-Solving Ability of Undergraduate Students. *International Journal of Instruction*, *15*(2), 981–996. https://doi.org/10.29333/iji.2022.15254a
Cohen, L., Manion, L., & Morrison, K. (2008). Research Methods in Education. In JETP Letters (Vol. 86, Issue 10). Rountledge Falmer taylor & Francis Group. https://doi.org/10.1134/S0021364007220055
Conway, J. H. (2004). How to Solve it. In *Stochastic Optimization in Continuous Time*. https://doi.org/10.1017/cbo9780511616747.007
Corbin, J. M., & Strauss, A. (1990). Grounded theory research: Procedures, canons, and evaluative criteria. *Qualitative Sociology*, *13*(1), 3–21. https://doi.org/10.1007/BF00988593
Corbin, J., & Strauss, A. (2011). Grounded theory methodology FU Skript. *Handbook of Qualitative Research*, *000*, 273–285.
Costa, W. (2010). *Investigando A Conversão Da Escrita Natural Para Registros Em Escrita Algébrica Em Problemas Envolvendo Equações De Primeiro Grau* [Universidade Federal de Pernambuco]. https://repositorio.ufpe.br/bitstream/123456789/3808/3/arquivo48_1.pdf.txt

Crawford, M. L. (2001). Teaching Contextually. CCI Publishing, Inc.
Creswell, J.W. (2012). *Educational Research Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (K. Mason (ed.); fourth edi). http://repository.unmas.ac.id/medias/journal/EBK-00121.pdf
Creswell, J.W., & Poth, C. . (2018). A Book Review: Qualitative Inquiry & Research Design: Choosing Among Five Approaches. In *Russian Journal of Sociology* (Fourth Edi, Vol. 3, Issue 1). Sage Publications, Inc. https://doi.org/10.13187/rjs.2017.1.30
Creswell, J. W. (2014). *Research design: qualitative, quantitative, and mixed methods approaches* (4th ed.). Sage Publications, Inc.
Creswell, John W. (2012). *Educational Research Planning, Conducting, and Evaluating Quantitative and Qualitative Research* (K. Mason (ed.); FOURTH EDI). http://repository.unmas.ac.id/medias/journal/EBK-00121.pdf
Creswell, John W., & Brown, M. L. (1992). How chairpersons enhance faculty research: A grounded theory study. *The Review of Higher Education*, *16*(1), 41–62. https://doi.org/10.1353/rhe.1992.0002
Dahiana, W. O., Herman, T., Nurlaelah, E., & Pereira, J. (2023). *Student Semiotic Representation Skills in Solving Mathematics Problems*. *4185*(2009), 34–47. https://doi.org/10.24815/jdm.v10i1.30770
Dahlan, J. A., & Juandi, D. (2011a). Analisis Representasi Matematik Siswa Sekolah Dasar Dalam Penyelesaian Masalah Matematika Kontekstual. *Jurnal Pengajaran Matematika Dan Ilmu Pengetahuan Alam*, *16*(1), 128. https://doi.org/10.18269/jpmipa.v16i1.273
Danesi, M. (2004). *Messages, Signs, Semiotics and and Meanings A Basic Textbook Communication* (3rd editio). Canadian Scholars' Press Inc.
Daugaard, D. (2020). Emerging new themes in environmental, social and governance investing: a systematic literature review. *Accounting and Finance*, *60*(2), 1501–1530. https://doi.org/10.1111/acfi.12479
Flores, C. R. (2008). Semiotic representation in mathematics: History, epistemology, learning. Bolema Boletim de Educação Matemática https://www.researchgate.net/publication/279340555
Demirel, M., Derman, I., & Karagedik, E. (2015). A Study on the Relationship between Reflective Thinking Skills towards Problem Solving and Attitudes towards Mathematics. *Procedia - Social and Behavioral Sciences*, *197*(February), 2086–2096. https://doi.org/10.1016/j.sbspro.2015.07.326
Denzin. (1978). The research act : A theoretical introduction to sociological methods. (2nd ed.). McGrawHill.
Denzin. (1989). The Research Act: A Theoretical Introduction to Sociological Methods. (Third edition). Prentice Hall.
Dewey, J. (1933). How we think: A restatement of relation of reflective thinking and

education process. D.C. Heath.
Dewi, C.L., & Hakim, D. L. (2023). Representasi Semiotik Matematis Siswa SMA Dalam Masalah Aplikasi Turunan Fungsi Aljabar. *Jurnal Educatio FKIP UNMA*, *9*(1), 32–34. https://doi.org/10.31949/educatio.v9i1.4115
Driscoll, M., Zawojeski, J., Humez, A., Nikula, J., Goldsmith, L., & Hammerman, J. (2001). *The Fostering Algebraic Thinking Toolkit A Guide for Staff Development*.
Duval, R. (2000). Basic Issues for Research in Mathematics Education. *Proceedings of the Conference of the International Group for the Psychology of Mathematics Education (PME), I*, 55–69.
Duval, R. (2006). A cognitive analysis of problems of comprehension in a learning of mathematics. *Educational Studies in Mathematics*, *61*(1–2), 103–131. https://doi.org/10.1007/s10649-006-0400-z
Duval, R. (2017). Understanding the mathematical way of thinking - The registers of semiotic representations. In *Understanding the Mathematical Way of Thinking - The Registers of Semiotic Representations*. https://doi.org/10.1007/978-3-319-56910-9
Erzberger, C., & Prein, G. (1997). Triangulation: Validity and empirically-based hypothesis construction. Quality and Quantity, 31(2), 141–154. https://doi.org/10.1023/A:1004249313062
Etriana, Anriani, N., & Fathurrohman, M. (2018). Pengembangan Bahan Ajar Matematika Berbasis Kompetensi Abad 21 untuk Guru SMP/MTs. *Prosiding Seminar Dan Diskusi Nasional Pendidikan Dasar 2018:Menyongsong Transformasi Pendidikan Abad 21*, 1–5.
Farmaki, V., & Paschos, T. (2007). Employing genetic "moments" in the history of mathematics in classroom activities. *Educational Studies in Mathematics*, *66*(1), 83–106. https://doi.org/10.1007/s10649-006-9056-y
Feng, X., & Behar-Horenstein, L. (2019). Maximizing NVivo utilities to analyze open-ended responses. *Qualitative Report*, *24*(3), 563–571. https://doi.org/10.46743/2160-3715/2019.3692
Fery, M. F., Wahyudin, & Tatang, H. (2017). Improving primary students mathematical literacy through problem based learning and direct instruction. *Educational Research and Reviews*, *12*(4), 212–219. https://doi.org/10.5897/err2016.3072
Fielding-Wells, J., O'Brien, M., & Makar, K. (2017). Using expectancy-value theory to explore aspects of motivation and engagement in inquiry-based learning in primary mathematics. *Mathematics Education Research Journal*, *29*(2), 237–254. https://doi.org/10.1007/s13394-017-0201-y
Firdaus, F. I., & Ni'mah, K. (2020). Deskripsi Proses Berpikir Matematis Siswa dalam Memecahkan. *Jurnal Educatio FKIP UNMA*, *6*(2), 711–720.

Fischbein, E. (1999). Intuitions and schemata in mathematical reasoning. *Educational Studies in Mathematics*, *38*(1–3), 11–50. https://doi.org/10.1007/978-94-017-1584-3_2

Flores, A. (2002). Geometric representations in the transition from arithmetic to algebra. *Representations and Mathematics Visualization*, 9–29.

Frege, G. (2014). Begriffsschrift, a formula language, modeled upon that of arithmetic, for pure thought. *Frege and Gödel, 1879*, 1–82. https://doi.org/10.4159/harvard.9780674864603.c2

Frengky. (2012). Model Pembelajaran Matematika Siswa Kelas Satu Sekolah Dasar. *Jurnal Psikologi*, *35*, *NO. 2*,. https://jurnal.ugm.ac.id/jpsi/article/view/7949/6147

Fuadi, R., Johar, R., & Munzir, S. (2016). Peningkatkan kemampuan pemahaman dan penalaran matematis melalui pendekatan kontekstual. *Jurnal Didaktika Matematika*, *3*(1), 47–54. https://jurnal.usk.ac.id/DM/article/view/4305

Gagatsis, A., & Shiakalli, M. (2004). Ability to translate from one representation of the concept of function to another and mathematical problem solving. *Educational Psychology*, *24*(5), 645–657. https://doi.org/10.1080/0144341042000262953

Glaser, B. G. (1978). Theoretical sensitivity. Sociology Press.

Gonçalves, F. B. (2004). Estudos De Tradução E Semiologia: As Contribuições De Umberto Eco. *Organon*, *18*(37). https://doi.org/10.22456/2238-8915.31175

Guberman, R. (2016). Development of Arithmetical Thinking: Evaluation of Subject Matter Knowledge of Pre-Service Teachers in Order to Design the Appropriate Course. *International Journal of Science and Mathematics Education*, *14*(4), 739–755. https://doi.org/10.1007/s10763-014-9600-7

Harel, G. (2008a). DNR perspective on mathematics curriculum and instruction, Part I: Focus on proving. *ZDM - International Journal on Mathematics Education*, *40*(3), 487–500. https://doi.org/10.1007/s11858-008-0104-1

Harel, G. (2008b). What is Mathematics? A PedagogicalAnswer to a PhilosophicalQuestion. In B. Gold & R. A. Simons (Eds.), *Proofandother Dilemmas Mathematics andPhilosophy* (p. 346). The Mathematical Association of America.

Harel, G. (2013). DNR-Based Curricula: The Case of Complex Numbers. *Journal of Humanistic Mathematics*, *3*(2), 2–61. https://doi.org/10.5642/jhummath.201302.03

Harel, G., & Sowder, L. (2013a). Advanced mathematical-thinking at any age: Its nature and its development. *Advanced Mathematical Thinking: A Special Issue of Mathematical Thinking and Learning*, *December 2013*, 27–50. https://doi.org/10.4324/9781315045955

Harel, G., & Sowder, L. (2013b). Advanced mathematical-thinking at any age: Its nature and its development. *Advanced Mathematical Thinking: A Special Issue*

of Mathematical Thinking and Learning, *6065*, 27–50. https://doi.org/10.4324/9781315045955

Hariyanti, U., Irawan, E. B., & Hidayanto, E. (2017). Penalaran Proporsional Dalam Menyelesaikan Masalah Multiplikatif Tipe Product Of Measurement. *Jurnal Kajian Pembelajaran Matematika*.

Hilton, A., Hilton, G., Dole, S., & Goos, M. (2013). Development and application of a two-tier diagnostic instrument to assess middle-years students' proportional reasoning. *Mathematics Education Research Journal*, *25*(4), 523–545. https://doi.org/10.1007/s13394-013-0083-6

Hitt, F. (1998). Difficulties in the articulation of different representations linked to the concept of function. *Journal of Mathematical Behavior*, *17*(1), 123–134. https://doi.org/10.1016/s0732-3123(99)80064-9

Holmes, V.-L., Miedema, C., Nieuwkoop, L., & Haugen, N. (2013). Data-driven intervention: correcting mathematics students' misconceptions, not mistakes. *The Mathematics Educator*, *23*(1), 24–44.

Hornby, G., Witte, C., & Mitchell, D. (2011). Policies and practices of ability grouping in New Zealand intermediate schools. *Support for Learning*, *26*(3), 92–96. https://doi.org/10.1111/j.1467-9604.2011.01485.x

Houser, N. (2016). *Semiotics and Philosophy Semiótica e Filosofia*. 313–336.

Johar, R., & Lubis, K. R. (2018). The analysis of students' mathematical representation errors in solving word problems related to graph. Jurnal Riset Pendidikan Matematika, 5(1), 96– 107. https://doi.org/10.21831/jrpm.v5i1.17277

Jones, K., & Voutsina, C. (2017). Book Review: Approaches to qualitative research in mathematics education: Examples of methodology and methods, edited by Angelika Bikner-Ahsbahs, Christine Knipping, & Norma Presmeg. (2015). *Educational Studies in Mathematics*, *96*(3), 381–390. https://doi.org/10.1007/s10649-017-9784-1

Juandi, D., & A. J. (2013). Developing Mathematical Communication And Representation Of Students Grade Vii: A Design Research. *Pengajaran MIPA*, *18*, 135–145.

Jupri, A., & Drijvers, P. (2016). Student difficulties in mathematizing word problems in Algebra. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(9), 2481–2502. https://doi.org/10.12973/eurasia.2016.1299a

Jupri, A., Drijvers, P., & van den Heuvel-Panhuizen, M. (2014). Difficulties in initial algebra learning in Indonesia. *Mathematics Education Research Journal*, *26*(4), 683–710. https://doi.org/10.1007/s13394-013-0097-0

Jupri, A., Drijvers, P., & van den Heuvel-Panhuizen, M. (2015). Improving Grade 7 Students' Achievement in Initial Algebra Through a Technology-Based Intervention. *Digital Experiences in Mathematics Education*, *1*(1), 28–58.

https://doi.org/10.1007/s40751-015-0004-2
Jupri, A., Sispiyati, R., & Chin, K. E. (2021). An investigation of students algebraic proficiency from a structure sense perspective. *Journal on Mathematics Education*, *12*(1), 147–158. https://doi.org/10.22342/jme.12.1.13125.147-158
Kalathil, R. R., & Sherin, M. G. (2020). Role of Students' Representations in the Mathematics Classroom. *International Conference of the Learning Sciences*, 39–40. https://doi.org/10.4324/9780203763865-9
Kamarullah. (2017). Pendidikan matematika di sekolah kita. *Al Khawarizmi*.
Kaput, J. J., & Blanton, M. (2005). Characterizing a classroom practice that promotes algebraic reasoning. *Journal for Research in Mathematics Education*, *36*(5), 412.
Ketterlin-Geller, L. R., & Chard, D. J. (2011). Algebra readiness for students with learning difficulties in grades 4-8: Support through the study of number. *Australian Journal of Learning Difficulties*, *16*(1), 65–78. https://doi.org/10.1080/19404158.2011.563478
Kieran, C. (2004). Algebraic thinking in the early grades: What is it. *The Mathematics Educator*, *8*(1), 139–151.
Krefting, L. (1991). *Trustworthiness*. *45*(3), 214–222.
Krulik, S., & Rudnick, J. A. (1988). Problem Solving: A Handbook for Elementary School Teachers. In *Africa's potential for the ecological intensification of agriculture*.
Kulik, J. A., & Kulik, C. L. C. (1987). Effects of ability grouping on student achievement. *Equity and Excellence in Education*, *23*(1–2), 22–30. https://doi.org/10.1080/1066568870230105
Kurniawan, H. (2021). *Pengantar Praktis Menyusun Instrumen Penelitian*. CV Budi Utama.
Kuznetsov, E. A., Passot, T., & Sulem, P. L. (2008). Nonlinear theory of mirror instability near its threshold. *JETP Letters*, *86*(10), 637–642. https://doi.org/10.1134/S0021364007220055
Ladriere, R. (1997). *Referencia e sentido*. *76*, 89–100.
Lapan, MaryLynn T. Quartaroli, F. J. R. (2012). *Qualitative Research An Introduction to Methods and Designs* (First Edit). Jossey-Bass.
Larossa, R. (2005). Grounded Theory Methods and Qualitative Family Research. *Journal of Marriage and Family*, 837–857.
Larvor, B. P. (2006). Michel Serfati. La Revolution Symbolique: La Constitution de l'Ecriture Symbolique Mathematique. Preface by Jacques Bouverasse. Paris: Editions Petra, 2005. Pp. ix + 427. ISBN 2-84743-006-7. *Philosophia Mathematica*, *15*(1), 122–126. https://doi.org/10.1093/philmat/nkl026
Lefebvre, M. (2001). *Images , Écritures et Espace de médiation Étude anthropologique des pratiques graphiques* [Université Louis Pasteur –

Strasbourg I]. http://science.societe.free.fr/documents/pdf/These.M.Lefebvre.pdf
Lesh, R., Behr, M., & Post, T. (1987). *Rational number relations and proportions* (C. Janvier (ed.)). Hillsdale, NJ: Lawrence Erlbaum.
Lestariningsih, Nurhayati, E., & Cicinidia. (2020). Jenis Proses Berpikir Peserta Didik dalam Menyelesaikan Soal Literasi Matematis Mosharafa : Jurnal Pendidikan Matematika menerapkan model pembelajaran Problem Mosharafa : Jurnal Pendidikan Matematika. *Mosharafa: Jurnal Pendidikan Matematika*, *9*(1), 83 0 94.
Lew, H.-C. (2004). Developing Algebraic Thinking in Early Grades: Case Study of Korean Elementary School Mathematics. *The Mathematics Educator*, *8*(1), 88–106.
Li, B., & Ba, T. K. (2009). *Talim ve Terbiye Kurulu Başkanlığı*.
Li, X., Du, J., & Long, H. (2019). Green development behavior and performance of industrial enterprises based on grounded theory study: Evidence from China. *Sustainability (Switzerland)*, *11*(15), 1–19. https://doi.org/10.3390/su11154133
Lincoln YS, G. E. (1989). Naturalistic Inquiry. Sage Publications, Newbury Park CA.
Lins, R. C., & Bell, A. (1992). *A framework for understanding what algebraic*
Lithner, J. (2005). A Framework for Analysing Qualities of Mathematical Reasoning: Version 3. Research Reports in Mathematics Education 3. Umeå,. Department of%0AMathematics, Umeå University
Lithner, J. (2012). Learning Mathematics by Creative or Imitative Reasoning. Selected Regular Lectures from the 12th International Congress on Mathematical Education, 487–506. https://doi.org/10.1007/978-3-319- 17187-6_28
Loveless, T. (1998). The Tracking And Ability Grouping Debate. *Paper*, *1*, 12. https://eric.ed.gov/?id=ED417056
Lubis, Raka, B. (2023, Desember 10). *Mengulik Hasil PISA 2022 Indonesia: Peringkat Naik, tapi Tren Penurunan Skor Berlanjut*. [Diakses pada 20 April 2024] https://goodstats.id/article/mengulik-hasil-pisa-2022-indonesia-peringkat-naik-tapi-tren-penurunan-skor-berlanjut-m6xdt
Luis Radford. (2015). the Epistemological Foundations of the General Theory. *Scottish Journal of Political Economy*, *35*(3), 227–241. https://doi.org/10.1111/j.1467-9485.1988.tb01048.x
Magne, O. (2001). *Literature on special educational needs in mathematics: A bibliography with some comments*. https://www.diva-portal.org/smash/record.jsf?pid=diva2:1410418%0Ahttps://www.diva-portal.org/smash/get/diva2:1410418/Fulltext01.pdf
Manly, M., & Ginsburg, L. (2010). *Algebraic Thinking in Adult Education*. *September*, 20. internal-pdf://0169661638/algebra_paper_2010V.pdf
Martin, M. O., & Mullis, I. V. (2019). *Assessment Frameworks* TIMSS & PIRLS International Study Center, Lynch School of Education, Boston College and

International Association for the Evaluation of Educational Achievement. https://timss2019.org/wp-content/uploads/frameworks/T19-Assessment-Frameworks.pdf

Martin, M. O., & Mullis, I. V. S. (2015). International Results in Science. *TIMSS Internation Study Center*, 162–173.

Mason, J. (1996). *Expressing generality and roots of algebra* (N. B. et al. (eds.) (ed.)). Kluwer Academic Publishers.

McClung, L. W. (1992). *A study on the use of manipulatives and their effect on student achievement in high school algebra 1 course*. 85.

McGee, D. L., & Martinez-Planell, R. (2014). a Study of Semiotic Registers in the Development of the Definite Integral of Functions of Two and Three Variables. *International Journal of Science and Mathematics Education*, *12*(4), 883–916. https://doi.org/10.1007/s10763-013-9437-5

Morrow, S. L., & Smith, M. L. (2007). A grounded theory study: Constructions of survival and coping by women who have survived childhood sexual abuse. *Qualitative Inquiry and Research Design: Choosing*, *42*(1), 90-91;285-308.

Morse, J. M. (2001). The Cultural Sensitivity of Grounded Theory. *Qualitative Health Research*, *11*(6), 721–722. https://doi.org/10.1177/104973201129119406

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

Mullis, I. V. S., Martin, M. O., Foy, P., Kelly, D. L., & Fishbein, B. (2019). Timss 2019 International Results in Mathematics and Science Timss & Pirl. In *International Association for the Evaluation of Educational Achievement*. https://www.iea.nl/sites/default/files/2021-01/TIMSS 2019-International-Results-in-Mathematics-and-Science.pdf

Munasiah, M., Solihah, A., & Heriyati, H. (2020). Pemahaman Konsep dan Penalaran Matematika Siswa dalam Pembelajaran Matriks. *SAP (Susunan Artikel Pendidikan)*, *5*(1). https://doi.org/10.30998/sap.v5i1.6231

Nasriadi, A., & Sari, I. K. (2019). Proses Berpikir Matematis Mahasiswa Stkip Bina Bangsa Getsempena Dalam Memecahkan Masalah Estimasi. *Numeracy*, *6*(1), 40–53. https://doi.org/https://doi.org/10.46244/numeracy.v6i1.425

Natcha Kamol, & Yeah Ban Har. (2010). Shaping the future of mathematics education: Proceedings of the 33rd Annual Conference of the Mathematics Education Research Group of Australasia. In *Upper primary school students' algebraic thinking* (Issue July).

NCTM. (2000). *principles and standards with the learning from assements materials*. http://www.wested.org/Ifa/NCTM%0A2000.PDF. %0A

NCTM. (2014). Principles to actions. Ensuring mathematical success for all. National Council of Teachersof Mathematics.

http://www.nctm.org/uploadedFiles/Math_Standards/12752_exec_pssm.pdf.
NCTM. (2020). Standards for the preparation of middle level mathematics teachers. National Council of Teachers of Mathematics.
Nickerson, R. S. (2010). Mathematical Reasoning: Patterns, Problems, Conjectures. *Reviews of Human Factors and Ergonomics*, *6*(1), 257–258. https://doi.org/10.1518/155723410x12877040391235
Nizam. (2016). Ringkasan Hasil-hasil Asesmen. *Pusat Penilaian Pendidikan Badan penelitian dan pengembangan kementerian pendidikan dan kebudayaan*.
Nolting, P. D. (1994). Mathematics Study Skills: A Must For Students With LD. *Intervention in School and Clinic*, *30*(1), 53–59. https://doi.org/10.1177/105345129403000109
Nolting, P. D. (2010). *Math Study Skills Workbook : Your Guide to Reducing Text Anxiety and Improving Study Strategies*.
Novita, D., Cahyaningtyas, & Toto. (2018). Analysis of Student Algebra Thinking Process. *Jurnal Pendidikan Matematika Dan Sains*, *4*(1), 50–60.
Novitasari, L., & Leonard. (2017). Pengaruh Kemampuan Pemahaman Konsep Matematika terhadap Hasil Belajar Matematika. *Prosiding Diskusi Panel Nasional Pendidikan Matematika. Fakultas Teknik, Matematika, Dan Ilmu Pengetahuan Alam Universitas Indraprasta PGRI.*, 758–766. https://journal.lppmunindra.ac.id/index.php/repository/article/view/1952
Nurhasanah, H., Turmudi, & Jupri, A. (2021). Karakteristik Ways of Thinking (WoT) dan Ways of Understanding (WoU) siswa berdasarkan teori Harel. *Journal of Authentic Research on Mathematics Education (JARME)*, *3*(1), 105–113. https://doi.org/10.37058/jarme.v3i1.2449
Ojo, S. G. (2022). Effects of Animated Instructional Packages on Achievement and Interest of Junior Secondary School Student in Algebra. *Mathematics Teaching-Research Journal*, *14*(1), 99–113.
Oliveira,P.C., & Pires, R. F. (2012). *O Conceito De Função Na Educação Básica Via*. *15*, 215–239. https://www.geplam.ufscar.br/arquivos/publicacoes/artigos-de-revistas/artigo-4.pdf
Osman, S., Abu, M. S., Mohammad, S., & Mokhtar, M. (2015). Identifying pertinent elements of critical thinking and mathematical thinking used in civil engineering practice in relation to engineering education. *Qualitative Report*, *21*(2), 212–227. https://doi.org/10.46743/2160-3715/2016.2203
Panasuk, R. M. (2001). Taxonomy For Assessing Conceptual Understanding In Algebra Using Multiple Representations. *College Student Journal*.
Panasuk, R. M. (2011). Taxonomy for Assessing Conceptual Understanding in Algebra. *College Student Journal*, *45*(2), 219–232.
Papadimos, T. J. (2009). Reflective thinking and medical students: Some thoughtful distillations regarding John Dewey and Hannah Arendt. *Philosophy, Ethics, and*

Humanities in Medicine, *4*(1). https://doi.org/10.1186/1747-5341-4-5

Permatasari, D., & Harta, I. (2018). Kemampuan Berpikir Aljabar Siswa Sekolah Pendidikan Dasar Kelas V Dan Kelas Vii: Cross-Sectional Study. *Jurnal Pendidikan Dan Kebudayaan*, *3*(1), 99. https://doi.org/10.24832/jpnk.v3i1.726

Pino-Fan, L. R., Guzmán, I., Duval, R., & Font, V. (2015a). The Theory of Register of Semiotic Representation and the Onto-Semiotic Approach to Mathematical Cognition and Instruction: Linking Looks for the Study of Mathematical Understanding. *Proceedings of 39th Psychology of Mathematics Education Conference*, *4*(July), 33–40.

Pino-Fan, L. R., Guzmán, I., Duval, R., & Font, V. (2015b). The Theory of Registers of Semiotic Representation and the Onto-semiotic Approach to Mathematical Cognition and Instruction: Linking Looks for the Study of Mathematical Understanding. *Proceedings of the 39th Conference of the International Group for the Psychology of Mathematics Education*, 33–40. http://www.igpme.org/publications/current-proceedings/

Pradono, J., Hapsari, D., Supardi, S., & Budiarto, W. (2018). *Panduan Manajemen Penelitian Kuantitatif* (Trihono (ed.)).

Pramesti, T. I., & Retnawati, H. (2019). Difficulties in learning algebra: An analysis of students' errors. *Journal of Physics: Conference Series*, *1320*(1). https://doi.org/10.1088/1742-6596/1320/1/012061

Puspita, R. (2018). *Kemendikbud: Rerata UN Matematika SMA Turun*. Republika.Co.Id. https://www.republika.co.id/berita/p8f0zb428/kemendikbud-rerata-un-matematika-sma-turun

Putra, D. P. W., & Kristanto, Y. D. (2017). Some Aspects on Students' Mathematical Reasoning in Exploring Group Theory. *International Conference on Research in Education*, *June*, 219–230.

Putra, I. P. (2023, Desember 26). *Telegramlink Kaleidoskop Pendidikan 2023: Peringkat PISA 2022 Naik, Tapi Skor Turun. Diakses dari* https://www.medcom.id/pendidikan/news-pendidikan/zNAQVqzN-kaleidoskop-pendidikan-2023-peringkat-pisa-2022-naik-tapi-skor-turun

Putri, R. I., & Santosa, R. H. (2015). Keefektifan Strategi React Ditinjau Dari Prestasi Belajar, Kemampuan Penyelesaian Masalah, Koneksi Matematis, Self Efficacy. Jurnal Riset Pendidikan Matematika, 2(2), 262. https://doi.org/10.21831/jrpm.v2i2.7345

Radford, L. (2000). *Signs and Meanings in Students' Emergent Algebraic Thinking: A Semiotic Analysis*. 237–268.

Richter, L. E., Carlos, A., & Beber, D. M. (1989). *Descartes's Mathematical Thought*. Princeton University.

Rijali, A. (2019). Analisis Data Kualitatif. *Alhadharah: Jurnal Ilmu Dakwah*, *17*(33), 81. https://doi.org/10.18592/alhadharah.v17i33.2374

Risdiyanto, R. (2021). Pengelompokan Berdasarkan Kemampuan (Ability Grouping) dan Dampaknya bagi Peserta Didik. *Inovasi Kurikulum*, *18*(1), 73–81. https://doi.org/10.17509/jik.v18i1.36405

Roller, M. R. &, & Lavrakas, P. J. (2015). *Applied Qualitative Research Design A Total Quality Framework Approach*. The Guilford Press.

Rosa, N. (2022, April 1). *Yang Ditunggu, Ini Hasil Lengkap Asesmen Nasional 2021*. Diaksese dari https://www.detik.com/edu/edutainment/d-6011654/yang-ditunggu-ini-hasil-lengkap-asesmen-nasional-2021

Rosita, N. T., Sukestiyarno, Y. L., Kartono, & Mulyono. (2019). The Analysis of Students Mathematical Reasoning in Completing the Word Problem in SMPN 7 Sumedang. Advances in Social Science, Education and Humanities Research, 443(ISET 2019), 115–119. https://doi.org/10.2991/assehr.k.200620.023

Rubin, D. (2022). Interview with Don Rubin. *Observational Studies*, *8*(2), 77–94. https://doi.org/10.1353/obs.2022.0009

Sabirin, M. (2014). Representasi dalam Pembelajaran Matematika. *Jurnal Pendidikan Matematika*, *1*(2), 33. https://doi.org/10.18592/jpm.v1i2.49

Sadeghi, F., Mohammad, S., Adel, R., Zareian, G., & Davoudi, M. (2020). Iranian EFL Teachers' and Learners' Perceptions of the Principles of Critical Thinking: A Constructivist Grounded Theory Study Article history Iranian Journal of Language Teaching Research. *Iranian Journal of Language Teaching Research*, *8*(2), 63–81. http://ijltr.urmia.ac.ir

Sáenz-Ludlow & Kadunz. (2016). Semiotics as a Tool for Learning Mathematics: How to Describe the Construction, Visualisation, and Communication of Mathematical Concepts by Adalira Sáenz-Ludlow & Gert Kadunz (Eds.). In Presmeg Norma (Ed.), *Mathematical Thinking and Learning* (Vol. 18, Issue 3). Rotterdam, The Netherlands: Sense Publishers. https://doi.org/10.1080/10986065.2016.1184953

Sani, R. . (2016). *Penilaian Autentik*. Jakarta: Bumi Aksara.

Sari, I., Marwan, M., & Hajidin, H. (2019). Students' Thinking Process in Solving Mathematical Problems in Build Flat Side Spaces of Material Reviewed from Adversity Quotient. *Malikussaleh Journal of Mathematics Learning (MJML)*, *2*(2), 61–67. https://doi.org/10.29103/mjml.v2i2.1468

Schoenfeld, A. H. (1989). Problem Solving in Context(s). *Lawrence Erlbaum Associates, Publishers, Mahwah, New Jersey, London*. https://www.researchgate.net/publication/313048861_Problem_Solving_in_Contexts

Schoenfeld, A. H. (2016). *Mathematical Thinking And Problem Solving* (A. H. Schoenfeld (ed.); Third). Routledge.

Serrazina, L., & Rodrigues, M. (2018). *The role of representations in promoting the quantitative reasoning To cite this version : hal id : hal-01950535*.

Sharp, J. H. (2011). *Semiotics as a Theoretical Foundation of Information Design*. *4*(March), 6. www.aitp-edsig.org

Shurter, R. L., & Pierce, J. R. (1966). Critical Thinking. Mc Graw Hill Inc.

Silva, F. A. F., Santiago, M. M. L., & Dos Santos, M. C. (2014). Meanings and representations of rational numbers addressed in the national high school exam-ENEM. *Bolema - Mathematics Education Bulletin*, *28*(50), 1485–1504. https://doi.org/10.1590/1980-4415v28n50a23

Smith, J. (1973). *The Effect of General Versus Specific Heuristics in Mathematical Problem-Solving Tasks*. Columbia.

Smith, R. W., & Kounios, J. (1996). Sudden insight: All-or-none processing revealed by speed-accuracy decomposition. *Journal of Experimental Psychology: Learning Memory and Cognition*, *22*(6), 1443–1462. https://doi.org/10.1037/0278-7393.22.6.1443

Sofyan, Y., Sumarni, S., & Riyadi, M. (2021). Pengembangan Perangkat Pembelajaran Pada Materi Bangun Ruang Sisi Datar Berbasis Model Project Based Learning Untuk Meningkatkan Kemampuan Pemecahan Masalah Matematis Siswa. *Sigma: Jurnal Pendidikan Matematika*, *13*(2), 129–142. https://doi.org/10.26618/sigma.v13i2.5832

Sowder, H. (1998). Students Proof Schemes: Results from Eksploratory Studies. *American Mathematical Society*, *7*(CBMS Issues in Mathematics Education).

Stacey, K. (2006). What Is Design Thinking and Why Is It Important? *Review of Educational Research*, *82*(3), 330–348. https://doi.org/10.3102/0034654312457429

Sternberg, R. J., & Karin, S. (2012). Psychology & Cognitive (Sixth Edit). Wadsworth, Cengage Learning all. https://doi.org/10.1201/b10547-16

Strauss & Corbin. (1994). *Grounded Theory Methodology*. https://vu.fernuni-hagen.de/lvuweb/lvu/file/FeU/KSW/2016SS/33800/oeffentlich/33800-vorschau.pdf

Strauss, A., & Corbin, J. (1998). Basics of Qualitative Research: Techniques and Procedures for Developing Grounded Theory. Thousand Oaks, CA: Sage Publications, Inc.

Sulianto, J., Sunardi, S., & Anitah, S. (2020). Classification of Student Reasoning Skills in Solving Mathematics Problems in Elementary School. https://ejournal.undiksha.ac.id/index.php/JPI/article/view/23103

Suryadi, D. (2012). *Membangun Budaya Baru dalam Berpikir Matematika*. Rizqi Press.

Suryadi, D. (2019). *Landasan Filosofis Penelitian Desain Didaktis (DDR)*. Pusat Pengembangan DDR Indonesia, Universitas Pendidikan Indonesia.

Suryowati, E. (2021). Proses berpikir fungsional siswa SMP dalam menyelesaikan soal matematika. *AKSIOMA : Jurnal Matematika Dan Pendidikan Matematika*,

12(1), 109–119. https://doi.org/10.26877/aks.v12i1.7082

Tarp, A. (2009). Mathematical applications and modelling in the teaching and learning of mathematics. Proceedings from Topic Study Group 21 at the 11th International Congress on Mathematical ducation in Monterrey, Mexico, July 6-13, 2008. In M. Blomhøj (Ed.), *Mathematical applications and modelling in the teaching and learning of mathematics. Proceedings from Topic Study Group 21 at the 11th International Congress on Mathematical ducation in Monterrey, Mexico, July 6-13, 2008* (p. 85).

Tekin-Sitrava, R. (2017). Middle Grade Students' Concept Images of Algebraic Concepts. *Journal of Education and Learning*, *6*(3), 299. https://doi.org/10.5539/jel.v6n3p299

Thellefsen, M. M., Thellefsen, T., & Sørensen, B. (2018). Information as signs: A semiotic analysis of the information concept, determining its ontological and epistemological foundations. *Journal of Documentation*, *74*(2), 372–382. https://doi.org/10.1108/JD-05-2017-0078

Trifonas, P. P. (2015). International handbook of semiotics. *International Handbook of Semiotics*, *June*, 1–1308. https://doi.org/10.1007/978-94-017-9404-6

Uminingtyas, M. P. K., Sukarmin, S., & Suryana, R. (2019). *The Profile of 21st Century Learning: Enhancing critical thinking and problem solving skills at Senior High School*. *253*(Aes 2018), 24–30. https://doi.org/10.2991/aes-18.2019.7

Uzun, S. Ç., & Arslan, S. (2009). Semiotic representations skills of prospective elementary teachers related to mathematical concepts. *Procedia - Social and Behavioral Sciences*, *1*(1), 741–745. https://doi.org/10.1016/j.sbspro.2009.01.130

Valeirão, K., & Schio, S. M. (2017). Michel Foucault: As Palavras E As Coisas. In J. Do Carmo (Ed.), *Angewandte Chemie International Edition, 6(11), 951–952.* Filosofia.

van Amerom, B. (2002). Reinvention of early algebra. In *Developmental research on the transition from arithmetic to algebra*.

Vincent, J., Chick, H., & McCrae, B. (2005). Argumentation Profile Charts As Tools for Analysing Students' Argumentations. Proceedings of the 29th Conference of the International Group for the Psychology of Mathematics Education, 4, 281–288.

Wahyuni T. (2018). *Peneliti RISE: Indonesia Gawat Darurat Matematika*. Suara Karya.Co.Id. https://suarakarya.co.id/tag/indonesia-gawat-darurat-matematika/

Wardhani, S. (2010). *implikasi karakteristik matematika dalam penacapaian tujuan mata pelajaran matematika di smp/mts*.

Wardina, A. S., & Sudihartinih, E. (2019). Description of Student'S Junior High School Mathematical Connection Ability on the Linear Function Topic. *Journal*

of Mathematics Science and Education, *2*(1), 24–35. https://doi.org/10.31540/jmse.v2i1.813

Warren, E., & Cooper, T. (2008). Generalising the pattern rule for visual growth patterns: Actions that support 8 year olds' thinking. *Educational Studies in Mathematics*, *67*(2), 171–185. https://doi.org/10.1007/s10649-007-9092-2

Wijaya, C. . (2018). Analisis Kemampuan Representasi Matematis Siswa Dalam Menyelesaikan Soal Lingkaran Pada Kelas VII-B Mts Assyafi'iyah Gondang. *Suska Journal of Mathematics Education*, *4*(2), 115. https://doi.org/10.24014/sjme.v4i2.5234

Wilk, V., Soutar, G. N., & Harrigan, P. (2019). Tackling social media data analysis. *Qualitative Market Research: An International Journal*, *22*(2), 94–113. https://doi.org/10.1108/qmr-01-2017-0021

Windsor, W. (2010). Algebraic Thinking : A Problem Solving Approach. *Proceedings of the 33rd Annual Conference of the Mathematics Education Research Group of Australasia*, *33*, 665–672. https://research-repository.griffith.edu.au/bitstream/handle/10072/36557/67823_1.pdf?sequence=1&isAllowed=y

Windsor, W., & Norton, S. (2011). Developing Algebraic Thinking : Using A Problem Solving Approach in A Primary School Context. *Mathematics : Traditions And [New]Practices*, *March*, 813–820.

Yakin, H. S. M., & Totu, A. (2014). The Semiotic Perspectives of Peirce and Saussure: A Brief Comparative Study. *Procedia - Social and Behavioral Sciences*, *155*(October), 4–8. https://doi.org/10.1016/j.sbspro.2014.10.247

Ye, F. (2005). *Diagnostic Assessment Of Urban Middle School Student Learning Of Pre-Algebra Patterns*. *1*(1), 1–8.

Yin, R. K. (2015). *Qualitative research from start to finish.* (2nd ed.). New York: Guilford Publications.