PENINGKATAN KEMAMPUAN PEMECAHAN MASALAH GEOMETRI DAN *SELF-EFFICACY* MATEMATIS SISWA SMA MELALUI PEMBELAJARAN INVESTIGASI

DISERTASI

Diajukan untuk Memenuhi Sebagian Syarat untuk Memperoleh Gelar Doktor Ilmu Pendidikan Program Studi Pendidikan Matematika

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PROGRAM STUDI PENDIDIKAN MATEMATIKA
SEKOLAH PASCASARJANA
UNIVERSITAS PENDIDIKAN INDONESIA
2020

The Enhancement Senior High School Students' Geometry Problem Solving Ability and Mathematical Self-Efficacy through Investigative Learning

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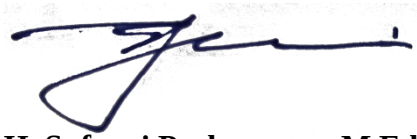

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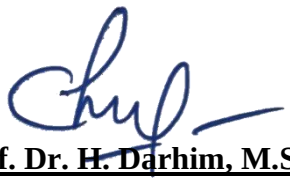

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ABSTRAK

Fiki Alghadari (2020). Peningkatan Kemampuan Pemecahan Masalah Geometri dan *Self-Efficacy* Matematis Siswa SMA Melalui Pembelajaran Investigasi.

Pencapaian geometri siswa mendapat poin rendah pada hasil survey dan penilaian dari tahun ke tahun berdampak pada peningkatan kemampuan pemecahan masalah geometri (PMG) dan *self-efficacy* matematis (SEM). Kemampuan PMG adalah kemampuan siswa memecahkan masalah jarak pada bangun ruang yang dirancang menurut level van Hiele. SEM adalah derajat keyakinan siswa terhadap kemampuan dirinya untuk benar memecahkan suatu masalah geometri. Kemampuan PMG dan SEM dapat didorong melalui kegiatan yang melibatkan proses investigasi. Proses investigasi melibatkan tahap *entry*, *attack*, *review*, dan *extension*. Penelitian ini mengkaji peningkatan kemampuan PMG dan SEM melalui pembelajaran investigasi pada siswa kelas XII-IPS tahun pelajaran 2018/2019 di satu SMA Tanjungpandan, Bangka Belitung. Penelitian ini menerapkan kuasi eksperimen dengan desain pretes-postes kelompok kontrol. Data dianalisis berdasarkan perbedaan pembelajaran, gender, dan tingkat kemampuan dasar geometri (KDG). Hasil analisis menyimpulkan bahwa terdapat perbedaan kemampuan PMG siswa signifikan berdasarkan gender dan tingkat KDG, namun tidak berdasarkan pembelajaran. Sedangkan pencapaian SEM siswa, hanya berbeda signifikan berdasarkan tingkat KDG tetapi tidak berdasarkan pembelajaran maupun gender. Pengaruh interaksi pembelajaran dan gender adalah signifikan terhadap kemampuan PMG, tetapi tidak pada pengaruh interaksi pembelajaran dan tingkat KDG. Sementara terhadap SEM siswa, hanya signifikan pada pengaruh interaksi pembelajaran dan tingkat KDG. Secara bersama-sama bahwa KDG dan kedua model SEM, yaitu *mathematics test-taking* dan *mathematics skill*, berpengaruh terhadap kemampuan PMG siswa, baik dimoderasi pembelajaran maupun gender.

Kata kunci: geometri, investigasi, pemecahan masalah, *self-efficacy*.

ABSTRACT

Fiki Alghadari (2020). The Enhancement Senior High School Students' Geometry Problem Solving Ability and Mathematical Self-Efficacy through Investigative Learning.

Students' achievements in geometry were low on surveys and assessments results from year to year have an impact on enhancing geometry problem solving (GPS) ability and mathematical self-efficacy (MSE). GPS ability is the students' ability to solve the problem of the distance in solid that was designed based on van Hiele's level. SEM is the degree of students' confidence in their ability to solve a geometry problem correctly. GPS ability and MSE can be encouraged through activities involving an investigative process. The investigation process involves entry, attack, review, and extension phase. This research is to study an enhancement students' GPS ability and mathematical self-efficacy (MSE) through investigative learning for 12th social program students in the academic year 2018/2019 at the one high school at Tanjungpandan Bangka Belitung. This research applied quasi-experiment by the pretest-postest control group design. Data were analyzed based on differences in the learning approach, gender, and the geometry ability (BGA) of basic level. The analysis result concluded that there is significant difference of students' GPS ability based on gender and BGA level category, but not for the learning approach. At the same time, a students' MSE achievement just significant different based on the BGA level but it is not for both of learning approach and gender. An interaction effect between learning approach and gender is significant toward GPS ability, but not for interaction between learning approach and BGA level. While the students' MSE, just significantly at the interaction effect between learning approach and BGA level. Parallely that BGA and two MSE models, that is mathematics test-taking and mathematics skill, affected to students' GPS ability, as well moderated by learning approach and gender.

Keywords: geometry, investigation, problem solving, self-efficacy.

DAFTAR ISI

DAFTAR PUSTAKA

Alghadari, F., Turmudi, T., & Herman, T. (2018). The Application of Vector Concepts on Two Skew Lines. *Journal of Physics: Conference Series*, *948*(1), 012030.

Alghadari, F. (2016). Pemecahan Masalah Spasial Matematis Calon Guru Matematika Ditinjau dari Langkah-langkah Pemecahan Masalah Polya. *Jurnal Penelitian Pendidikan*, *16*(3), 226–234.

Alghadari, F, & Herman, T. (2018). The Obstacles of Geometric Problem-Solving on Solid with Vector and Triangle Approach. *Journal of Physics: Conference Series*, *1132*(1), 012046.

Alghadari, F., & Kusuma, A. P. (2018). Pendekatan Analogi untuk Memahami Konsep dan Definisi dari Pemecahan Masalah. In T. Subroto & M. S. Noto (Eds.), *Seminar Nasional Matematika dan Pendidikan Matematika II* (pp. 113–122). Cirebon: Unswagati Press.

Anderson, J. R. (1981). Tuning of Search of the Problem Space for Geometry Proofs. *Proceedings of the 7th international joint conference on Artificial intelligence*, 1, 165-170.

Anderson, J. R., Boyle, C. F., & Yost, G. (1985). The Geometry Tutor. *Proceedings of the 9th international joint conference on Artificial intelligence*, 1, 1-7.

Arends, R. I. (2015). *Learning to Teach*. NY: McGraw-Hill Education.

Arikunto, S. (2013). *Dasar-dasar Evaluasi Pendidikan*. Jakarta: Bumi Aksara.

Aurah, C., Cassady, J. C., & McConnell, T. (2014). Predicting Problem Solving Ability from Metacognition and Self-Efficacy Beliefs on a Cross Validated Sample. *British Journal of Education*, *2*(1), 49–70.

Aydın, U. (2018). Conceptual and procedural angle knowledge: do gender and grade level make a difference?. *International Journal for Mathematics Teaching and Learning*, *19*(1), 22-46.

Bandura, A. (1977). Self-Efficay: Toward a Unifying Theory of Behavioral Change. *Psychological Review*, *84*(2), 191–215.

Bartholomew, S. R., & Strimel, G. J. (2018). Factors Influencing Student Success on Open-Ended Design Problems. *International Journal of Technology and Design Education*, *28*(3), 753–770.

Bernacki, M. L., Nokes-Malach, T. J., & Aleven, V. (2015). Examining Self-Efficacy During Learning: Variability and Relations to Behavior,

Performance, and Learning. *Metacognition and Learning*, *10*(1), 99–117.

Bhowmick, S., Young, J. A., Clark, P. W., & Bhowmick, N. (2017). Marketing Students' Mathematics Performance: The Mediating Role of Math Anxiety on Math Self-Concept and Math Self-Efficacy. *Journal of Higher Education Theory & Practice*, *17*(9), 104–117.

Buckley, J., Seery, N., & Canty, D. (2019). Investigating the Use of Spatial Reasoning Strategies in Geometric Problem Solving. *International Journal of Technology and Design Education*, *29*(2), 341–362.

Budhi, W.S. (2014). *Geometri*. Tangerang: Universitas Terbuka Press.

Cetin, S. Y., Erel, S., & Ozalp, O. (2018). Assessment of Problem Solving Proficiencies with Self-Efficacy Perceptions of students in faculty of Health Sciences of Cyprus International University. *SHS Web of Conferences*, *48*(1), 01025.

Chang, Y. L. (2015). Examining Relationships among Elementary Mathematics Teachers' Efficacy and Their Students' Mathematics Self-Efficacy and Achievement. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(6), 1307–1320.

Charles, R., Lester, F., & O'Daffer, P. (1994). *How to Evaluate Progress in Problem Solving*. Reston, VA: NCTM, Inc.

Cheng, K. K., Thacker, B. A., Cardenas, R. L., & Crouch, C. (2004). Using an Online Homework System Enhances Students' Learning of Physics Concepts in an Introductory Physics Course. *American Journal of Physics*, *72*(11), 1447–1453.

Christofferson, H. C. (1938). Geometry—A Way of Thinking. *The Educational Forum*, *3*(1), 39-48.

Cohen, R. J., & Swerdlik, M. E. (2018). Psychological Testing and Assessment: An Introduction to Tests and Measurement. USA: McGraw Hill Companies.

Collins, J. S., Usher, E. L., & Butz, A. (2015). Examining Students' Perceived Autonomy Support as a Source of Self-Efficacy in Mathematics. *Poster Session Presented at the Annual Meeting of the American Education Research Association*, 1.

Damaryanti, D. D., Mariani, S., & Mulyono, M. (2017). The Analysis of Geometrical Reasoning Ability Viewed from Self-Efficacy on Connected Mathematic Project (CMP) Learning Etnomathematics-Based. *Unnes Journal of Mathematics Education*, *6*(3), 325-332.

Demetriou, A., Shayer, M., & Efklides, A. (2005). *Neo-Pagietian Theories of*

Cognitive Development: Implications and Applications for Education. NY: Routledge.

Dhlamini, Z. B., Chuene, K., Masha, K., & Kibirige, I. (2019). Exploring Grade Nine Geometry Spatial Mathematical Reasoning in the South Exploring Grade Nine Geometry Spatial Mathematical Reasoning in the South African Annual National Assessment. *Eurasia Journal of Mathematics, Science and Technology Education*, *15*(11), em1772.

Dindyal, J. (2015). Geometry in the Early Years: a Commentary. *ZDM*, *47*(3), 519–529.

Dossey, J. A. (2017). Problem Solving from a Mathematical Standpoint. In C. Benő & F. Joachim (Eds.), *Educational Research and Innovation: The Nature of Problem Solving Using Research to Inspire 21st Century Learning* (pp. 59–72). Paris: OECD Publishing.

Edmonds, W. A., & Kennedy, T. D. (2017). *An Applied Guide to Research Designs: Quantitative, Qualitative, and Mixed Methods*. USA: Sage Publications.

Ernest, P. (1991). *The Philosophy of Mathematics Education*. UK: Routledge.

Franklin, J. (2014). *An Aristotelian Realist Philosophy of Mathematics: Mathematics as the Science of Quantity and Structure*. UK: Macmillan Publishers.

Fujita, T., Kondo, Y., Kumakura, H., & Kunimune, S. (2017). Students' Geometric Thinking with Cube Representations: Assessment Framework and Empirical Evidence. *Journal of Mathematical Behavio*, *40*(3), 96–111.

Gagne, R. M., Wager, W. W., Golas, K. C., & Keller, J. M. (2005). *Principles of Instructional Design*. USA: Thomson Learning.

Genschel, U., Kaplan, A., Carriquiry, A., Johnston, E., Kliemann, W., Koehler, K., & Nguyen, H. (2014). Statistical and Mathematical Self-Efficacy of Incoming Students at a Large Public University. *Sustainability in Statistics Education, Proceedings of the Ninth International Conference on Teaching Statistics*, *9*, 1–4.

Gilbert, M. C., Musu-Gillette, L. E., Woolley, M. E., Karabenick, S. A., Strutchens, M. E., & Martin, W. G. (2013). Student Perceptions of the Classroom Environment: Relations to Motivation and Achievement in Mathematics. *Learning Environments Research*, *17*(2), 287–304.

Goos, M., Dole, S., & Makar, K. (2007). Supporting an Investigative Approach to Teaching Secondary School Mathematics: A Professional Development Model. *Mathematics: Essential Research, Essential Practice*, *1*, 325–334.

Goos, M., Stillman, G., & Vale, C. (2017). *Teaching Secondary School Mathematics: Research and Practice for the 21st Century*. Australia: Allen & Unwin.

Granberg, C. (2016). Discovering and Addressing Errors during Mathematics Problem-Solving-A Productive Struggle? *Journal of Mathematical Behavior*, *42*, 33–48.

Greeno, J. G. (1979). *Constructions in Geometry Problem Solving*. Learning Researchand Development Center, University of Pittsburgh.

Grigg, S., Perera, H. N., McIlveen, P., & Svetleff, Z. (2018). Relations among Math Self Efficacy, Interest, Intentions, and Achievement: A Social Cognitive Perspective. *Contemporary Educational Psychology*, *53*, 73–86.

Hansen, M. (1993). What is Geometry?. *Mathematics in School*, 22, 9-11.

Hathaway, D., & Norton, P. (2018). *Understanding Problems of Practice A Case Study in Design Research*. USA: Springer.

Hedges, B. B. (1921). Geometry Detected by Sherlock Holmes. *The Mathematics Teacher*, *14*(3), 128-136.

Herbst, P., Fujita, T., Halverscheid, S., & Weiss, M. (2017). *The Learning and Teaching of Geometry in Secondary Schools: A Modeling Perspective*. New York: Routledge.

Hidayat, B. R., Sugiarto, B., & Pramesti, G. (2013). Analisis Kesalahan Siswa dalam Menyelesaikan Soal pada Materi Ruang Dimensi Tiga Ditinjau dari Gaya Kognitif Siswa. *Jurnal Pendidikan Matematika Solusi*, *1*(1), 39–46.

Hock, T. T., Tarmizi, R. A., Aida, A. S., & Ayub, A. F. (2015). Understanding the Primary School Students' van Hiele Levels of Geometry Thinking in Learning Shapes and Spaces: A Q-methodology. *Eurasia Journal of Mathematics, Science and Technology Education*, *11*(4), 793–802.

Hodiyanto, H. (2017). Pengaruh Model Pembelajaran Problem Solving terhadap Kemampuan Komunikasi Matematis Ditinjau dari Gender. *Jurnal Riset Pendidikan Matematika*, *4*(2), 219-228.

Holder, J. J. (1994). An Epistemological Foundation for Thinking: A Deweyan Approach. *Studies in Philosophy and Education*, *13*(3–4), 175–192.

Honicke, T., & Broadbent, J. (2016). The Influence of Academic Self-Efficacy on Academic Performance: A systematic review. *Educational Research Review*, *17*, 63–84.

Huang, C. (2013). Gender Differences in Academic Self-Efficacy: A Meta-Analysis. *European Journal of Psychology of Education*, *28*(1), 1–35.

Huang, X., Zhang, J., & Hudson, L. (2018). Impact of math self-efficacy, Math Anxiety, and Growth Mindset on Math and Science Career Interest for Middle School Students: The Gender Moderating Effect. *European Journal of Psychology of Education*, 1–20.

Hwang, W. Y., & Hu, S. S. (2013). Analysis of Peer Learning Behaviors Using Multiple Representations in Virtual Reality and their impacts on Geometry Problem Solving. *Computers and Education*, *62*, 308–319.

Ikhsanudin, I. (2014). Pengaruh Penggunaan Pembelajaran Kooperatif Tipe STAD Berbantuan Wingeom terhadap Kemampuan Pemecahan Masalah Geometri Siswa SMA. *Aksioma: Journal of Mathematics Education*, *3*(1), 40–49.

Imhausen, A. (2016). *Mathematics in Ancient Egypt: A Contextual History*. Princeton, NJ: Princeton University Press.

In'am, A. (2014). The Implementation of The Polya Method in Solving Euclidean Geometry Problems. *International Education Studies*, *7*(7), 149–158.

Jameson, M. M., & Fusco, B. R. (2014). Math Anxiety, Math Self-Concept, and Math Self-Efficacy in Adult Learners Compared to Traditional Undergraduate Students. *Adult Education Quarterly*, *64*(4), 306–322.

Jojo, Z. (2016). Learners' Interpretation of Geometric Concepts in The Intermediate Phase: The Case of Limpopo Province. *The Social Sciences*, *11*(10), 2606–2616.

Joshi, A., Kale, S., Chandel, S., & Pal, D. (2015). Likert Scale: Explored and Explained. *British Journal of Applied Science & Technology*, *7*(4), 396–403.

Jupri, A., & Syaodih, E. (2017). Between Formal and Informal Thinking: The Use of Algebra for Solving Geometry Problems from the Perspective of Van Hiele Theory. *Jurnal Pengajaran MIPA*, *21*(2), 108–113.

Kilpatrick, J., Swafford, J., & Findell, B. (2001). *Adding it Up: Helping Children Learn Mathematics*. Washington, DC: National Academies Press.

King, B. M., Rosopa, P. J., & Minium, E. W. (2011). *Statistical Reasoning in the Behavioral Science*. USA: John Wiley & Sons, Inc.

Kivkovich, N. (2015). A Tool for Solving Geometric Problems Using Mediated Mathematical Discourse (for Teachers and Pupils). *Procedia - Social and Behavioral Sciences*, *209*(1), 519–525.

Kline, R. (2011). Principles and Practice of Structural Equation Modeling. In D.

A. Kenny & T. D. Little (Eds.), *Clinical Orthopaedics and Related Research* (3rd ed.). New York: The Guilford Press.

Kondo, Y., Fujita, T., Kunimune, S., Jones, K., & Kumakura, H. (2014). The Influence of 3D Representations on Students Level of 3D Geometrical Thinking. *Proceedings of PME 38 and PME-NA 36*, 25–32.

Kösa, T. (2016). Effects of Using Dynamic Mathematics Software on Pre-Service Mathematics Teachers Spatial Visualization Skills: The case of Spatial Analytic Geometry. *Educational Research and Reviews*, *11*(7), 449–458.

Kospentaris, G., Vosniadou, S., Kazi, S., & Thanou, E. (2016). Visual and Analytic Strategies in Geometry. *Frontline Learning Research*, *4*(1), 40–57.

Koyuncu, I., Akyuz, D., & Cakiroglu, E. (2015). Investigating Plane Geometry Problem-Solving Strategies of Prospective Mathematics Teachers in Technology and Paper-and-Pencil Environments. *International Journal of Science and Mathematics Education*, *13*(4), 837–862.

Krismanto, A. (2008). *Pembelajaran Sudut dan Jarak Dalam Ruang Dimensi Tiga*. Yogyakarta: Departemen Pendidikan Nasional.

Kubiszyn, T., & Borich, G. D. (2016). *Educational Testing and Measurement: Classroom Application and Practice*. USA: John Wiley & Sons, Inc.

Kundu, A., & Ghose, A. (2016). Gender Related Difference in the Acquisition of Van Hiele Level in Geometry of higher Secondary Students in West Bengal. *Internafional Journal of Mulfidisciplinary Educafional Research*, *5*(6), 3, 74-87.

Lin, J. J. H., & Lin, S. S. J. (2014). Cognitive Load for Configuration Comprehension in Computer-Supported Geometry Problem Solving: an Eye Movement Perspective. *International Journal of Science and Mathematics Education*, *12*(3), 605–627.

Lin, L., Lee, T., & Snyder, L. A. (2018). Math Self-Efficacy and STEM Intentions: A Person-Centered Approach. *Frontiers in Psychology*, *9*, 1–13.

Lishinski, A., Yadav, A., Good, J., & Enbody, R. (2016). Learning to Program: Gender Differences and Interactive Effects of Students' Motivation, Goals, and Self-Efficacy on Performance. *ACM Conference on International Computing Education Research*, 211–220.

Luneta, K. (2015). Understanding Students' Misconceptions: An Analysis of Final Grade 12 Examination Questions in Geometry. *Pythagoras*, *36*(1), 1–11.

Maciejewski, W. (2016). Instructors' Perceptions of Their Students' Conceptions: The Case in Undergraduate Mathematics. *International Journal of Teaching*

and Learning in Higher Education, *28*(1), 1–8.

Maddux, J. E., & Kleiman, E. M. (2016). Self-Efficacy: A Foundational Concept for Positive Clinical Psychology. In A. M. Wood & J. Johnson (Eds.), *The Wiley Handbook of Positive Clinical Psychology* (1st ed., pp. 89–101). UK: John Wiley & Sons, Ltd.

Mainali, B. (2019). Investigating the Relationships between Preferences, Gender, Task Difficulty, and High School Students' Geometry Performance. *International Journal of Research in Education and Science*, *5*(1), 224-236.

Martin, M. O., Mullis, I. V. S., & Foy, P. (2008). *TIMSS 2007 International Mathematics Report: Findings from IEA's Trends in International Mathematics and Science Study at the Fourth and Eighth Grades*. USA: TIMSS & PIRLS International Study Center.

Mayer, R. E. (1998). Cognitive, Metacognitive, and Motivational Aspects of Problem Solving. *Instructional Science*, *26*, 49–63.

McDougal, T., & Colton, N. (2009). Mathematics Lesson Plan for 7th Grade — Square Roots. *Chicago Lesson Study Conference*, 1–6.

Minarti, E. D., Wahyudin, & Alghadari, F. (2018). Student's Conceptions and Geometry Problem-Solving of the Distance in Cube. *Journal of Physics: Conference Series*, *1132*(1), 012033.

Mithalal, J., & Balacheff, N. (2019). The Instrumental Deconstruction as a Link Between Drawing and Geometrical Figure. *Educational Studies in Mathematics*, *100*(2), 161–176.

Mullis, I. V. S., Martin, M. O., Foy, P., & Arora, A. (2012). *TIMSS 2011 International Results in Mathematics*. USA: TIMSS & PIRLS International Study Center.

Murphy, P. E. (2016). Student Approaches to Learning, Conceptions of Mathematics, and Successful Outcomes in Learning Mathematics. In L. N. Wood & Y. A. Breyer (Eds.), *Success in Higher Education* (pp. 75–93). Singapore: Springer.

Musa, L. A. D. (2016). Level Berpikir Geometri menurut Teori Van Hiele berdasarkan Kemampuan Geometri dan Perbedaan Gender pada Siswa Kelas VII SMP Negeri 8 Parepare. *Al-Khwarizmi: Jurnal Pendidikan Matematika Dan Ilmu Pengetahuan Alam*, *4*(2), 103–116.

Narpila, S. D. (2016). Peningkatan Kemampuan Spasial dan Self Efficacy Siswa Melalui Pembelajaran Inquiry Berbantuan Software Cabri. *Jurnal Tarbiyah*, *23*(1), 150–173.

Natalliasari, I., & Mulyani, E. (2017). Implementasi Pembelajaran Investigasi Berbantuan Software Cabri 3D terhadap Kemampuan Pemecahan Masalah Matematis dan Kemandirian Belajar Mahasiswa. *Jurnal Penelitian Pendidikan Dan Pengajaran Matematika*, *3*(1), 27–32.

NCTM. (2000). *Principles and Standards for School Mathematics*. Reston, VA: NCTM, Inc.

Novak, E., & Tassell, J. L. (2017). Studying Preservice Teacher Math Anxiety and Mathematics Performance in Geometry, Word, and Non-Word Problem Solving. *Learning and Individual Differences*, *54*, 20–29.

OECD. (2017). *PISA 2015 Assessment and Analytical Framework: Science, Reading, Mathematic, Financial Literacy and Collaborative Problem Solving*. Paris: OECD Publishing.

OECD. (2019a). PISA 2018 Results (Volume I): What Students Know and Can Do. Paris: OECD Publishing.

OECD. (2019b). PISA 2018 Results (Volume III): What School Life Means for Students' Lives. Paris: OECD Publishing.

Pavlovicova, G., & Zahorska, J. (2015). The Attitudes of Students to the Geometry and Their Concepts about Square. *Procedia-Social and Behavioral Sciences*, *197*, 1907–1912.

Pedemonte, B., & Balacheff, N. (2016). Establishing Links Between Conceptions, Argumentation and Proof Through the ck¢-Enriched Toulmin Model. *Journal of Mathematical Behavior*, *41*, 104–122.

Pepper, D., Hodgen, J., Lamesoo, K., Kõiv, P., & Tolboom, J. (2018). Think Aloud: Using Cognitive Interviewing to Validate the PISA Assessment of Student Self-Efficacy in Mathematics. *International Journal of Research and Method in Education*, *41*(1), 3–16.

Permendikbud. (2016). *Kompetensi Inti dan Kompetensi Dasar Pelajaran pada Kurikulum 2013 pada Pendidikan Dasar dan Pendidikan Menengah*. Jakarta: Kementrian Pendidikan Nasional.

Pittalis, M., & Christou, C. (2010). Types of Reasoning in 3D Geometry thinking and Their Relation with Spatial Ability. *Educational Studies in Mathematics*, *75*(2), 191–212.

Prabawanto, S. (2013). *Peningkatan Kemampuan Pemecahan Masalah, Komunikasi dan Self-Efficacy Matematis Mahasiswa melalui Pembelajaran dengan Pendekatan Metakognitif Scaffolding*. Universitas Pendidikan Indonesia.

Prabawanto, S. (2017). The Enhancement of Students' Mathematical Problem Solving Ability through Teaching with Metacognitive Scaffolding Approach. *AIP Conference Proceedings*, *1848*(1), 040014.

Puspendik. (2017). Laporan Hasil Ujian Nasional. Retrieved September 2, 2019, from Kementerian Pendidikan dan Kebudayaan website: https://hasilun.puspendik.kemdikbud.go.id/#2017!sma!daya_serap!99&

Puspendik. (2018). Laporan Hasil Ujian Nasional. Retrieved September 2, 2019, from Kementerian Pendidikan dan Kebudayaan website: https://hasilun.puspendik.kemdikbud.go.id/#2018!sma!daya_serap!99&

Putri, W. K. H. W., & Prabawanto, S. (2019). The Analysis of Students' Self-Efficacy in Learning Mathematics. *Journal of Physics: Conference Series*, *1157*(3), 032113.

Rabab'h, B., & Veloo, A. (2015). Spatial Visualization as Mediating Between Mathematics Learning Strategy and Mathematics Achievement among 8th Grade Students. *International Education Studies*, *8*(5), 1–11.

Radmehr, F., & Drake, M. (2018a). An Assessment-Based Model for Exploring the Solving of Mathematical Problems: Utilizing Revised Bloom's Taxonomy and Facets of Metacognition. *Studies in Educational Evaluation*, *59*, 41–51.

Radmehr, F., & Drake, M. (2018b). Revised Bloom's Taxonomy and Major Theories and Frameworks that Influence the Teaching, Learning, and Assessment of Mathematics: A Comparison. *International Journal of Mathematical Education in Science and Technology*, 1–26.

Rahayu, T., & Alghadari, F. (2019). Identitas Bayangan Konsep Limas : Analisis Terhadap Konsepsi Matematis Siswa. *Inomatika: Jurnal Inovasi Matematika*, *1*(1), 7–20.

Rahman, A., & Ahmar, A. S. (2016). Exploration of Mathematics Problem Solving Process Based on the Thinking Level of Students in Junior High School. *International Journal of Environmental and Science Education*, *11*(14), 7278–7285.

Ramdhani, M. R., Usodo, B., & Subanti, S. (2017). Discovery Learning with Scientific Approach on Geometry. *Journal of Physics: Conference Series*, *895*(1), 012033.

Ramlan, A. M. (2016). The Effect of van hiele learning model toward Geometric Reasoning Ability Based on Self-Efficacy of Senior High School Students. *Journal of Mathematics Education*, *1*(2), 64–71.

Reed, S. K. (2015). The Structure of Ill-Structured (and Well-Structured) Problems Revisited. *Educational Psychology Review*, *28*(4), 691–716.

Riastuti, N., Mardiyana, M., & Pramudya, I. (2017). Students' Errors in Geometry Viewed from Spatial Intelligence. *Journal of Physics: Conference Series*, *895*(1), 012029.

Ridho, M., Hartoyo, A., & Bistari, B. (2015). Penggunaan Software Cabri Pada Peningkatan Kemampuan Pemecahan Masalah Materi Dimensi Tiga Kelas X SMA. *Jurnal Pendidikan Dan Pembelajaran*, *4*(6), 1–13.

Risdianto, H., Karnasih, I., & Siregar, H. (2013). The Difference of Enhancement Mathematical Problem Solving Ability and Self-Efficiency SMA with MA Students IPS Program through Guided Inquiry Learning Model Assisted Autograph Software in Langsa. *Jurnal Pendidikan Matematika Paradikma*, *6*(1), 89–108.

Romey, W. D. (1970). What is Your Creativity Quotient?. *School Science and Mathematics*, *70*(1), 3-8.

Rosadi, A., M. Amin, S., & Sulaiman, R. (2018). Problem Solving Geometry of Visualization, Analysis, and Informal Deduction Subject Based on SOLO Taxonomy. *Pancaran Pendidikan*, *7*(2), 11–18.

Rosilawati, & Alghadari, F. (2018). Konsepsi Siswa pada suatu Bentuk Bangun Ruang Terkait dengan Rusuk dan Diagonal Sisi. *Prisma: Jurnal Pendidikan Matematika*, *7*(2), 164–176.

Roth, W. M., & Thom, J. S. (2009). Bodily experience and Mathematical Conceptions: From Classical Views to a Phenomenological Reconceptualization. *Educational Studies in Mathematics*, *70*(2), 175–189.

Ruseffendi, H. E. T. (2010). *Dasar-dasar Penelitian Pendidikan dan Bidang Noneksakta Lainnya*. Bandung: Tarsito.

Sahin, S. M., & Kendir, F. (2013). The Effect of Using Metacognitive Strategies for Solving Geometry Problems on Students' Achievement and Attitude. *Educational Research and Reviews*, *8*(19), 1777–1792.

Savard, A. (2014). Developing Probabilistic Thinking: What About People's Conceptions? In G. Kaiser & B. Sriraman (Eds.), *Probabilistic Thinking* (pp. 283–298). Dordrecht: Springer.

Scherer, P., Beswick, K., Deblois, L., & Healy, L. (2017). Assistance of Students with Mathematical Learning Difficulties—How Can Research Support Practice ?—A Summary Inclusive education Introduction : Mathematics Learning, Special Education. In G. Kaiser (Ed.), *Proceedings of the 13th International Congress on Mathematical Education* (pp. 249–259). Cham:

Springer.

Schoenfeld, A. H. (2014). *Mathematical Problem Solving*. UK: Academic Press.

Schoenfeld, A. H. (2016). Learning to Think Mathematically: Problem Solving, Metacognition, and Sense Making in Mathematics (Reprint). *Journal of Education*, *196*(2), 1–38.

Schunk, D. H., & Dibenedetto, M. K. (2016). Self-Efficacy Theory in Education. In K. R. Wentzel & D. B. Miele (Eds.), *Handbook of Motivation at School* (pp. 34–54). UK: Routledge.

Sellwood, P. (1991). The Investigative Learning Process. *Design and Technology Teaching*, *24*(1), 4–12.

Setiadi, D. R., Suryadi, D., & Mulyana, E. (2017). Didactical Design Enrichment of Angle in Geometry. *Journal of Physics: Conference Series*, *895*(1), 012060.

Silk, K. J., & Parrott, R. L. (2014). Math Anxiety and Exposure to Statistics in Messages about Genetically Modified Foods: Effects of Numeracy, Math Self-Efficacy, and form of Presentation. *Journal of Health Communication*, *19*(7), 838–852.

Simon, M. A. (2017). Explicating Mathematical Concept and Mathematical Conception as Theoretical Constructs for Mathematics Education Research. *Educational Studies in Mathematics*, *94*(2), 117–137.

Sinclair, N., Bussi, M. G. B., de Villiers, M., Jones, K., Kortenkamp, U., Leung, A., & Owens, K. (2016). Recent Research on Geometry Education: An ICME-13 Survey Team Report. *ZDM-Mathematics Education*, *48*(5), 691–719.

Skaalvik, E. M., Federici, R. A., & Klassen, R. M. (2015). Mathematics Achievement and Self-Efficacy: Relations with Motivation for Mathematics. *International Journal of Educational Research*, *72*, 129–136.

Storek, J., & Furnham, A. (2012). Gender and Gender Role Differences in Domain-Masculine Intelligence and Beliefs about Intelligence: A Study with Mensa UK Members. *Personality and Individual Differences*, *53*(7), 890–895.

Storek, J., & Furnham, A. (2014). Gender and Task Confidence as Predictors of the Domain-Masculine Intelligence Type (DMIQ). *Personality and Individual Differences*, *69*, 43–49.

Storek, J., & Furnham, A. (2016). The Role of Gender, Task Success Probability Estimation and Scores as Predictors of the Domain-Masculine Intelligence

Type (DMIQ). *Learning and Individual Differences*, *50*, 23–29.

Street, K. E. S., Malmberg, L. E., & Stylianides, G. J. (2017a). Level, Strength, and Facet-Specific Self-Efficacy in Mathematics Test Performance. *ZDM-Mathematics Education*, *49*(3), 379–395.

Sukoco, H., & Mahmudi, A. (2016). Pengaruh Pendekatan Brain-Based Learning terhadap Kemampuan Komunikasi Matematis dan Self-Efficacy Siswa SMA. *Pythagoras: Jurnal Pendidikan Matematika*, *11*(1), 11–24.

Sukri, S., Ismaimuza, D., & Sugita, G. (2017). Penerapan Model Pembelajaran Langsung Berbantuan Program Cabri 3D pada Materi Menentukan Besar Sudut dalam Ruang untuk Meningkatkan Hasil Belajar Siswa Kelas X SMA Al-Azhar Palu. *Jurnal Elektronik Pendidikan Matematika Tadulako*, *2*(2), 204–214.

Sumarna, N. (2016). *Peningkatan Kemampuan Pemahaman Matematis, Berpikir Kritis, Kreatif dan Penalaran Matematis pada Mahasiswa Calon Guru Sekolah Dasar melalui Pendekatan Pembelajaran Investigasi Matematik*. Universitas Pendidikan Indonesia.

Sumarna, N., Wahyudin, W., & Herman, T. (2017a). Improving the Ability of Mathematics (Conceptual and Procedural) Through Mathematical Investigation on Prospective Elementary Teachers. *1st International Conference of Mathematics and Science Education*, *57*, 73–79.

Sumarna, N., Wahyudin, W., & Herman, T. (2017b). The Increase of Critical Thinking Skills through Mathematical Investigation Approach. *Journal of Physics: Conference Series*, *812*(1), 012067.

Sumarna, Nana, & Sentryo, I. (2017). Improving of Prospective Elementary Teachers' Reasoning: Learning Geometry through Mathematical Investigation. *AIP Conference Proceedings*, *1868*(1), 050015.

Suryadi, D. (2005). *Penggunaan Pendekatan Pembelajaran Tidak Langsung serta Pendekatan Gabungan Langsung dan Tidak Langsung dalam Rangka Meningkatkan Kemampuan Berpikir Matematik Tingkat Tinggi Siswa SLTP*. Universitas Pendidikan Indonesia.

Susilawati, W., Suryadi, D., & Dahlan, J. A. (2017). The Improvement of Mathematical Spatial Visualization Ability of Student through Cognitive Conflict. *IEJME-Mathematics Education*, *12*(2), 155–166.

Susilo, M. B., & Retnawati, H. (2018). An Analysis of Metacognition and Mathematical Self-Efficacy Toward Mathematical Problem Solving Ability. *Journal of Physics: Conference Series*, *1097*(1), 012140.

Susmono, S., Kusmayadi, T. A., & Mardiyana, M. (2015). Eksperimentasi Model

Pembelajaran Think Talk Write (TTW) dan Think Pair Share (TPS) pada Pokok Bahasan Dimensi Tiga Ditinjau dari Kesulitan Belajar Siswa Kelas X SMA Negeri di Kabupaten Magetan Tahun Pelajaran 2012/2013. *Jurnal Pembelajaran Matematika*, *3*(1), 87–96.

Suwito, A., Yuwono, I., Parta, I. N., Irawati, S., & Oktavianingtyas, E. (2016). Solving Geometric Problems by Using Algebraic Representation for Junior High School Level 3 in van Hiele at Geometric Thinking Level. *International Education Studies*, *9*(10), 27–33.

Szymanowicz, A., & Furnham, A. (2013). Gender and Gender Role Differences in Self- and Other-Estimates of Multiple Intelligences. *Journal of Social Psychology*, *153*(4), 399–423.

Talmage, H., & Hart, A. (1977). Investigative Teaching of Mathematics and its Effect on the Classroom Learning Environment. *Journal for Research in Mathematics Education*, *8*(5), 345–358.

Tiurma, L., & Retnawati, H. (2015). Keefektifan Pembelajaran Multimedia Materi Dimensi Tiga Ditinjau dari Prestasi dan Minat Belajar Matematika di SMA. *Jurnal Kependidikan: Penelitian Inovasi Pembelajaran*, *44*(2), 175–187.

Tobinski, D. A., & Fritz, A. (2017). EcoSphere: A New Paradigm for Problem Solving in Complex Systems. In C. Benő & F. Joachim (Eds.), *Educational Research and Innovation: The Nature of Problem Solving Using Research to Inspire 21st Century Learning* (pp. 211–223).

Toland, M. D., & Usher, E. L. (2016). Assessing Mathematics Self-Efficacy: How Many Categories Do We Really Need? *Journal of Early Adolescence*, *36*(7), 932–960.

Usher, E. L., Ford, C. J., Li, C. R., & Weidner, B. L. (2019). Sources of Math and Science Self-Efficacy in Rural Appalachia: A Convergent Mixed Methods Study. *Contemporary Educational Psychology*, *57*, 32–53.

Utami, R. W., & Wutsqa, D. U. (2017). Analisis Kemampuan Pemecahan Masalah Matematika dan Self-Efficacy Siswa SMP Negeri di Kabupaten Ciamis. *Jurnal Riset Pendidikan Matematika*, *4*(2), 166-175.

Van de Walle, J., Karp, K., & Bay-Williams, J. (2017). *Elementary and Middle School Mathematics: Teaching Developmentally*. USA: Pearson Education.

Villavicencio, F. T., & Bernardo, A. B. I. (2016). Beyond Math Anxiety: Positive Emotions Predict Mathematics Achievement, Self-Regulation, and Self-Efficacy. *Asia-Pacific Education Researcher*, *25*(3), 415–422.

Wahyudin, & Dahlan, J. (2016). *Statistika Terapan Lanjut*. Bandung: Mandiri.

Ward, T. B. (2012). Problem Solving. In M. D. Mumford (Ed.), *Handbook of Organizational Creativity* (pp. 169–188). USA: Academic Press.

Wares, A., & Elstak, I. (2018). Constructive Struggle in Geometry Classrooms. *International Journal of Mathematical Education in Science and Technology*, *50*(5), 800–805.

Wieber, A. E., Evoy, K., McLaughlin, T. F., Derby, K. M., Kellogg, E., Williams, R. L., … Rinaldi, L. (2017). The Effects of a Modified Direct Instruction Procedure on Time Telling for a Third Grade Student with Learning Disabilities with a Brief Comparison of Interesting and Boring Formats. *Learning Disabilities: A Contemporary Journal*, *15*(2), 239–248.

Wu, Y. (2016). Universal Beliefs and Specific Practices: Students' Math Self-Efficacy and Related Factors in the United States and China. *International Education Studies*, *9*(12), 61–74.

Xu, M. L., & Leung, S. O. (2018). Effects of varying numbers of Likert Scale Points on Factor Structure of the Rosenberg Self-Esteem Scale. *Asian Journal of Social Psychology*, *21*(3), 119–128.

Xu, Z., & Jang, E. E. (2017). The Role of Math Self-Efficacy in the Structural Model of Extracurricular Technology-Related Activities and Junior Elementary School Students' Mathematics Ability. *Computers in Human Behavior*, *68*, 547–555.

Yeo, J. B. W. (2008). Secondary School Students Investigating Mathematics. *Methodology*, 613–619.

Yeo, J. B. W. (2017). Specialising and Conjecturing in Mathematical Investigation. *41st Conference of the International Group for the Psychology of Mathematics Education*, *4*, 337–344.

Yeo, J. B. W., & Yeap, B. H. (2010). Characterising the Cognitive Processes in Mathematical Investigation. *International Journal for Mathematics Teaching and Learning*, 1–10.

Yeo, J. B. W. (2013). The Nature and Development of Processes in Mathematical Investigation. Nanyang Technological University.

Yeo, J. B. W., & Yeap, B. H. (2010). Mathematical Investigation: Task, Process and Activity. *International Journal of Science and Mathematics Education*, *15*, 175–191.

Yeo, J. B. W, & Yeap, B. H. (2009). Solving Mathematical Problems by Investigation. In B. Kau, B. H. Yeap, & M. Kapur (Eds.), *Mathematical Problem Solving - Yearbook 2009, Association of Mathematics Educators* (pp. 118–135). Singapore: World Scientific Publishing.

Yilmaz, R., & Argun, Z. (2017). Role of Visualization in Mathematical Abstraction: The Case of Congruence Concept. *International Journal of Education in Mathematics, Science and Technology*, *6*(1), 41–57.

Yulianita, Y., Somakim, S., & Susanti, E. S. (2016). Desain Pembelajaran Sudut pada Bangun Ruang Menggunakan Pendekatan PMRI di Kelas X. *Jurnal Numeracy*, *3*(1), 1–14.

Yurt, E., & Sunbul, A. M. (2014). A Structural Equation Model Explaining 8th Grade Students' Mathematics Achievements. *Educational Sciences: Theory & Practice*, *14*(4), 1642–1652.

Zhang, D. (2017a). Effects of Visual Working Memory Training and Direct Instruction on Geometry Problem Solving in Students with Geometry Difficulties. *Learning Disabilities: A Contemporary Journal*, *15*(1), 117–138.

Zhang, C. (2017b). An Inquiry into Student Math Self-Efficacy, As Told from the Perspective of Ontario Secondary Teachers. University of Toronto.

Zhu, Y., & Fan, L. (2006). Focus on the Representation of Problem Types in Intended Curriculum: A Comparison of Selected Mathematics Textbooks from Mainland China and the United States. *International Journal of Science and Mathematics Education*, *4*(4), 609–626.

Zingaro, D. (2008). *Group Investigation: Theory and Practice What is Group Investigation?* pp. 1–8. Retrieved from http://www.academia.edu/download/41591261/gi.pdf