PENGEMBANGAN PLATFORM *DIGITAL LEARNING SPACES* DALAM MODEL *PROJECT-BASED LEARNING* DENGAN PENDEKATAN *SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS* UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR KREATIF MATEMATIS DAN OTONOMI BELAJAR SISWA

DISERTASI

Diajukan untuk Memenuhi sebagian Syarat Memperoleh Gelar Doktor Pendidikan Matematika

Oleh

RICKI YULIARDI

NIM 2002773

PROGRAM STUDI PENDIDIKAN MATEMATIKA

FAKULTAS PENDIDIKAN MATEMATIKA DAN ILMU PENGETAHUAN ALAM

UNIVERSITAS PENDIDIKAN INDONESIA

2025

==========

PENGEMBANGAN PLATFORM *DIGITAL LEARNING SPACES* DALAM MODEL *PROJECT-BASED LEARNING* DENGAN PENDEKATAN *SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS* UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR KREATIF MATEMATIS DAN OTONOMI BELAJAR SISWA

Oleh
Ricki Yuliardi

S.Pd. Universitas Pendidikan Indonesia, 2010
M.Pd Universitas Pendidikan Indonesia, 2013

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
Juli 2025

LEMBAR PENGESAHAN DISERTASI

RICKI YULIARDI
NIM. 2002773

PENGEMBANGAN PLATFORM *DIGITAL LEARNING SPACES* DALAM MODEL *PROJECT-BASED LEARNING* DENGAN PENDEKATAN *SCIENCE, TECHNOLOGY, ENGINEERING AND MATHEMATICS* UNTUK MENINGKATKAN KEMAMPUAN BERPIKIR KREATIF MATEMATIS DAN OTONOMI BELAJAR SISWA

Disetujui dan Disahkan oleh Tim Penguji Disertasi

Promotor

Prof. H. Yaya S. Kusumah, M.Sc., Ph.D.
NIP. 195909221983031003

Ko-Promotor

Prof. Dr. H. Dadang Juandi, M. Si.
NIP. 196401171992 021001

Anggota Promotor

Prof. Dr. Dra. Nurjanah, M.Pd.
NIP. 196511161990012001

Penguji

Dr. Jarnawi Afgani Dahlan, M.Kes
NIP. 196805111991011001

Penguji

Prof. Dr. Ahmad Fauzan, M. Pd, M. Sc
NIP : 196604301990011001

Mengetahui,
Ketua Program Studi S1, S2 dan S3 Pendidikan Matematika
Universitas Pendidikan Indonesia

Prof. Al Jupri, M.Sc. Ph.D.
NIP. 19820510 2005011 002

ABSTRAK

Ricki Yuliardi (2025)**. Pengembangan Platform *Digital Learning Spaces* (DLS) melalui Model *Project-Based Learning* (PjBL) dengan Pendekatan *Science, Technology, Engineering and Mathematics* (STEM) untuk Meningkatkan Kemampuan Berpikir Kreatif Matematis dan Otonomi Belajar Siswa.**

Penelitian ini bertujuan untuk mengembangkan Platform *Digital Learning Spaces* (DLS) dalam model *Project-Based Learning* (PjBL) dengan pendekatan STEM (*Science, Technology, Engineering, and Mathematics*) yang dirancang untuk meningkatkan kemampuan berpikir kreatif matematis dan otonomi belajar siswa. Latar belakang penelitian ini adalah rendahnya kemampuan berpikir kreatif siswa dan kurang berkembangnya otonomi belajar pada tingkat sekolah menengah pertama. Penelitian ini menggunakan metode *Research and Development* (*R&D*) dengan model pengembangan 4D (*Define, Design, Develop, Disseminate*). Produk yang dihasilkan berupa platform DLS yang terintegrasi *web* dengan fitur unggulan *Personal Learning Environment* (PLE) untuk siswa dan *Personal Teaching Environment* (PTE) untuk guru. Platform ini dirancang agar mendukung pembelajaran yang fleksibel, interaktif, dan adaptif terhadap kebutuhan siswa dan guru. Subjek penelitian yang dilibatkan dalam pengembangan DLS berbasis STEM terdiri dari beberapa tahap uji coba. Pada tahap pertama, dilakukan uji coba skala kecil yang melibatkan 10 siswa SMP dari satu sekolah di Kabupaten Kuningan untuk menguji prototipe awal. Selanjutnya, pada tahap kedua, uji coba diperluas dengan melibatkan 60 siswa dari dua sekolah yang berbeda di Kabupaten Kuningan. Tahap terakhir, yaitu uji lapangan (*field test*), melibatkan 180 siswa dari tiga sekolah berbeda di Kabupaten Kuningan, Jawa Barat. Pengujian validitas dilakukan oleh para ahli, sedangkan uji kepraktisan dan efektivitas dilakukan melalui implementasi terbatas di beberapa sekolah tersebut. Hasil uji validitas menunjukkan bahwa platform ini memenuhi kriteria valid berdasarkan evaluasi ahli. Uji kepraktisan menunjukkan platform DLS praktis digunakan oleh siswa dan guru, sementara uji efektivitas menunjukkan peningkatan signifikan dalam kemampuan berpikir kreatif matematis dan otonomi belajar siswa. Kesimpulannya, Platform *Digital Learning Spaces* melalui model PjBL berbasis STEM ini efektif dalam meningkatkan kemampuan berpikir kreatif matematis dan otonomi belajar siswa. Platform ini direkomendasikan untuk diterapkan lebih luas sebagai inovasi dalam pendidikan STEM di era digital.

Kata Kunci : *Digital Learning Spaces*, STEM, Berpikir Kreatif Matematis, Otonomi Belajar, Riset dan Pengembangan

ABSTRACT

Ricki Yuliardi (2025)**. Development of Digital Learning Spaces Platform through PjBL (Project-Based Learning) Model with STEM (Science, Technology, Engineering and Mathematics) Approach to Improve Students' Mathematical Creative Thinking Skills and Learning Autonomy.**

This study aims to develop a Digital Learning Spaces Platform (DLS) in the Project-Based Learning (PjBL) model with a STEM (Science, Technology, Engineering, and Mathematics) approach designed to improve students' mathematical creative thinking skills and learning autonomy. The background of this research is the low creative thinking abilities of students and the lack of development of learning autonomy at junior high school level. This research uses the Research and Development (R&D) method with the 4D development model (Define, Design, Develop, Disseminate). The resulting product is a web-integrated DLS platform with superior Personal Learning Environment (PLE) features for students and Personal Teaching Environment (PTE) for teachers. This platform is designed to support flexible, interactive and adaptive learning to the needs of students and teachers. The research subjects involved in developing STEM-based DLS consisted of several testing stages. In the first stage, a small-scale trial was carried out involving 10 junior high school students from one school in Kuningan Regency to test the initial prototype. Furthermore, in the second stage, the trial was expanded to involve 60 students from two different schools in Kuningan Regency. The final stage, namely the field test, involved 180 students from three different schools in Kuningan Regency, West Java. Validity testing was carried out by experts, while practicality and effectiveness testing was carried out through limited implementation in several schools. The validity test results show that this platform meets valid criteria based on expert evaluation. The practicality test shows that the DLS platform is easy to use by students and teachers, while the effectiveness test shows a significant increase in students' mathematical creative thinking abilities and learning autonomy. In conclusion, the Digital Learning Spaces Platform through PjBL (Project-Based Learning) Model with STEM is effective in improving the quality of learning. This platform is recommended for wider application as an innovation in STEM education in the digital era.

Keywords: Digital Learning Spaces, STEM, Mathematical Creativity, Learning Autonomy, Research and Development Model

DAFTAR ISI

Halaman

DAFTAR GAMBAR

DAFTAR TABEL

DAFTAR LAMPIRAN

DAFTAR PUSTAKA

Abdullah, N., Halim, L., & Zakaria, E. (2014). VStops: A thinking strategy and visual representation approach in mathematical word problem solving toward enhancing STEM literacy. *Eurasia Journal of Mathematics, Science and Technology Education*, *10*(3), 165–174. https://doi.org/10.12973/eurasia.2014.1073a

ABET. (2009). *2008 Annual Report For ABET Fiscal Year 2007-2008 Going Global Accreditation Takes Off Worldwide*.

Afriana, J., Permanasari, A., & Fitriani, A. (2016). Penerapan project based learning terintegrasi STEM untuk meningkatkan literasi sains siswa ditinjau dari gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 202. https://doi.org/10.21831/jipi.v2i2.8561

Alatas, F., & Yakin, N. A. (2021). The Effect of Science, Technology, Engineering, and Mathematics (STEM) Learning on Students' Problem Solving Skill. *JIPF (Jurnal Ilmu Pendidikan Fisika)*, *6*(1), 1. https://doi.org/10.26737/jipf.v6i1.1829

Alrawili, K. S., Osman, K., & Almuntasheri, S. S. (2022). Scaffolding Strategies in Promoting Attitudes of Saudi Middle School Science Students. *European Journal of Science and Mathematics Education*, *10*(1), 71–86. https://doi.org/10.30935/SCIMATH/11385

American Association for the Advancement of Science (AAAS). (1993). *Project 2061: Benchmarks for Science Literacy*.

Ananda, R. (2019). Penerapan metode mind mapping untuk meningkatkan kemampuan berpikir kreatif siswa Sekolah Dasar. *Edukatif: Jurnal Ilmu Pendidikan*, 1(1), 1–10. https://doi.org/10.31004/edukatif.v1i1.1

Anderson, T., & Dron, J. (2012). Overview • Three generations of distance education pedagogy. *International Review of Research in Open and Distributed Learning*, *13*(3), 80–97. https://doi.org/10.19173/irrodl.v13i3.889

Annisa, R., Effendi, M. H., & Damris, D. (2019). Peningkatan Kemampuan Berpikir Kreatif Siswa Dengan Menggunakan Model Project Based Learning Berbasis STEAM (Science, Technology, Engineering, Arts Dan Mathematic) Pada Materi Asam Dan Basa Di SMAN 11 Kota Jambi. *Journal of The Indonesian Society of Integrated Chemistry*, *10*(2), 14–22. https://doi.org/10.22437/jisic.v10i2.6517

Ardiansyah, A. S., Mulyono, Mashuri, Fiyanti, R. A., & Hamidah, F. S. (2021). CB-BL model (challenge based on blended learning) for mathematical creativity. *Journal of Physics: Conference Series*, *1918*(4). https://doi.org/10.1088/1742-6596/1918/4/042065

Arifin, A. M., Pujiastuti, H., & Sudiana, R. (2020). Pengembangan media pembelajaran STEM dengan augmented reality untuk meningkatkan kemampuan spasial matematis siswa. *Jurnal Riset Pendidikan Matematika*, *7*(1), 59–73. https://doi.org/10.21831/jrpm.v7i1.32135

Ashrafi, A., Zareravasan, A., Rabiee Savoji, S., & Amani, M. (2022). Exploring factors influencing students' continuance intention to use the learning management system (LMS): a multi-perspective framework. *Interactive Learning Environments*, *30*(8), 1475–1497. https://doi.org/10.1080/10494820.2020.1734028

Beers, S. Z. (2011). *21st century skills: Preparing students for their future*. Retrieved from https://www.mheonline.com/mhmymath/pdf/21st_century_skills.pdf

Benson, P. (2011). *Teaching and researching autonomy in language learning* (2nd ed.). Routledge. https://doi.org/10.4324/9781315833767

Leikin, R., Berman, A., & Koichu, B. (Eds.). (2009). *Creativity in mathematics and the education of gifted students*. Sense Publishers.

Biazus, M. de O., & Mahtari, S. (2022). The Impact of Project-Based Learning (PjBL) Model on Secondary Students' Creative Thinking Skills. *International Journal of Essential Competencies in Education*, *1*(1), 38–48. https://doi.org/10.36312/ijece.v1i1.752

Boholano, H. (2017a). Smart social networking: 21st Century teaching and learning skills. *Research in Pedagogy*, *7*(2), 21–29. https://doi.org/10.17810/2015.45

Brandt, W. C. (2020). *Measuring student success skills: A review of the literature on self-directed learning*. National Center for the Improvement of Educational Assessment. https://files.eric.ed.gov/fulltext/ED607782.pdf

Breiner, J. M., Harkness, S. S., Johnson, C. C., & Koehler, C. M. (2012). What Is STEM? A Discussion About Conceptions of STEM in Education and Partnerships. *School Science and Mathematics*, *112*(1), 3–11. https://doi.org/10.1111/j.1949-8594.2011.00109.x

Budiyono, A., Husna, H., & Wildani, A. (2020). Pengaruh Penerapan Model PBL Terintegrasi Steam Terhadap Kemampuan Berpikir Kreatif Ditinjau dari Pemahaman Konsep Siswa. *EDUSAINS*, *12*(2), 166–176. https://doi.org/10.15408/es.v12i2.13248

Buyung, B. (2021). Kemampuan berpikir kreatif matematis siswa smp melalui soal open ended. *Media Pendidikan Matematika*, *9*(2), 126. https://doi.org/10.33394/mpm.v9i2.4239

Bygstad, B., Øvrelid, E., Ludvigsen, S., & Dæhlen, M. (2022a). From dual digitalization to digital learning space: Exploring the digital transformation of higher education. *Computers & Education*, *182*, 104463. https://doi.org/10.1016/J.COMPEDU.2022.104463

Bygstad, B., Øvrelid, E., Ludvigsen, S., & Dæhlen, M. (2022b). From dual digitalization to digital learning space: Exploring the digital transformation of higher education. *Computers and Education*, *182*(January). https://doi.org/10.1016/j.compedu.2022.104463

Bygstad, B., Øvrelid, E., Ludvigsen, S., & Dæhlen, M. (2022c). From dual digitalization to digital learning space: Exploring the digital transformation of higher education. *Computers and Education*, *182*(January). https://doi.org/10.1016/j.compedu.2022.104463

Carmichael, E., & Farrell, H. (2012). Developing Student Critical Thinking: Review of Literature and Case Study of a Critical Thinking Online Site. In *Journal of University Teaching & Learning Practice* (Vol. 9, Issue 1). http://ro.uow.edu.au/jutlphttp://ro.uow.edu.au/jutlp/vol9/iss1/4

Chourishi, D. (2015). Effective E-Learning through Moodle Moodle for E-learning. *International Journal of Advance Technology & Engineering Research (IJATER)*, *1*(March 2012), 34.

Christman, J. (1991). Autonomy and Personal History. *Canadian Journal of Philosophy*, *21*(1), 1–24. https://doi.org/10.1080/00455091.1991.10717234

Cohen, J. (1988). *Statistical power analysis for the behavioral sciences* (2nd ed.). Lawrence Erlbaum Associates.

Colonnese, M. W. (2021). *Fostering Mathematical Creativity Through Problem Posing and Three-Act Tasks*. *44*(3), 141–150. https://doi.org/10.1177/10762175211008502

Creswell, J. (2014). *Research Design: Qualitative, Quantitative, and Mixed Methods Approaches*. Sage Publisher.

Dalilan, R., & Sofyan, D. (2022). Kemampuan berpikir kreatif matematis siswa SMP ditinjau dari self confidence. *Plusminus: Jurnal Pendidikan Matematika*, *2*(1), 141–150. https://doi.org/10.31980/plusminus.v2i1.1092

Dalsgaard, C., & Ryberg, T. (2023). A theoretical framework for digital learning spaces: learning in individual spaces, working groups, communities of interest, and open connections. *Research in Learning Technology*, *31*. https://doi.org/10.25304/rlt.v31.3084

Dam, L. (2011). Dam, L. (2011). Developing learner autonomy with school kids: Principles, practices, results. Edited by David Gardner. *Computers and Education: Artificial Intelligence*. https://doi.org/10.1016/j.caeai.2024.100224

Darwanto. (2019). KEMAMPUAN BERPIKIR KREATIF MATEMATIS (Pengertian dan Indikatornya). *Jurnal Eksponen*, *9*(2), 20–26. https://doi.org/10.47637/eksponen.v9i2.56

Davidi, E. I. N., Sennen, E., & Supardi, K. (2021a). Integrasi Pendekatan STEM (Science, Technology, Enggeenering and Mathematic) Untuk Peningkatan Keterampilan Berpikir Kritis Siswa Sekolah Dasar. *Scholaria: Jurnal Pendidikan Dan Kebudayaan*, *11*(1), 11–22. https://doi.org/10.24246/j.js.2021.v11.i1.p11-22

De porter, B., & Hernacki, M. (2009). *Quantum Learning*. PT. Mizan Pustaka.

Dewi, H. R., Mayasari, T., & Handhika, J. (2019). Increasing creative thinking skills and understanding of physics concepts through application of STEM-based inquiry. *JPPIPA (Jurnal Penelitian Pendidikan IPA)*, *4*(1), 25–30. https://doi.org/10.29303/jppipa.v4i1.5545

Dewi, S., & Kelana, J. B. (2019). Meningkatkan kemampuan berpikir kreatif IPA siswa sekolah dasar menggunakan model contextual teaching and learning. *COLLASE (Creative of Learning Students Elementary Education)*, *2*(6), 235–239. https://doi.org/10.22460/collase.v2i6.3401

Dias, M., & Brantley-Dias, L. (2017). Setting the Standard for Project Based Learning: A Proven Approach to Rigorous Classroom Instruction. *Interdisciplinary Journal of Problem-Based Learning*, *11*(2). https://doi.org/10.7771/1541-5015.1721

Dowling, S. (2012). Digital learning spaces – an alternative to traditional learning management systems? *International Journal of Excellence in eLearning*, *4*(2), 13–22.

Duchatelet, D., & Donche, V. (2019). Fostering self-efficacy and self-regulation in higher education: a matter of autonomy support or academic motivation? *Higher Education Research and Development*, *38*(4), 733–747. https://doi.org/10.1080/07294360.2019.1581143

Dziuban, C., Graham, C. R., Moskal, P. D., Norberg, A., & Sicilia, N. (2018). Blended learning: the new normal and emerging technologies. *International Journal of*

Educational Technology in Higher Education, *15*(1). https://doi.org/10.1186/s41239-017-0087-5

Effoduh, J. O. (2016). The Fourth Industrial Revolution by Klaus Schwab. *The Transnational Human Rights Review*, *3*(1), 1–10. https://doi.org/10.60082/2563-4631.1023.

El Geddawy, Y., Mikic-Fonte, F. A., Llamas-Nistal, M., & Caeiro-Rodríguez, M. (2022). Introducing Personal Teaching Environment for Nontraditional Teaching Methods. *Applied Sciences (Switzerland)*, *12*(15). https://doi.org/10.3390/app12157596

Ellis, G., & Sinclair, B. (1989). *Learning to Learn English a Course in Learner Training Teacher's Book.* Cambridge University Press.

Ersoy, E., & Başer, N. (2014). The effects of problem-based learning method in higher education on creative thinking. *Procedia - Social and Behavioral Sciences*, *116*, 3494–3498. https://doi.org/10.1016/j.sbspro.2014.01.790

Estapa, A. T., & Tank, K. M. (2017). Supporting integrated STEM in the elementary classroom: a professional development approach centered on an engineering design challenge. *International Journal of STEM Education*, *4*(1). https://doi.org/10.1186/s40594-017-0058-3

Ezzaidi (2020), Nurkamilah, N., & Badriyah, D. Q. (2022). Student'S Voices on Language Learner Autonomy in Distance Learning. *Journal of English Teaching, Applied Linguistics and Literatures (JETALL)*, *5*(2), 113. https://doi.org/10.20527/jetall.v5i2.13460

Fadel, C., & Trilling, B. (2009). *21st Century Skills: Learning for Life in Our Times* (Issue March 2009). San Francisco: Jossey-Bass.

Faelasofi, R. (2017). Identifikasi kemampuan berpikir kreatif matematika pokok bahasan peluang. *JURNAL E-DuMath*, 3(2), 155–163. https://doi.org/10.52657/je.v3i2.460

Feri, Z. O., & Erlinda, R. (2012). Building students' learning autonomy through collaborative learning to develop their language awareness. *Proceedings of the International Seminar on English Language and Teaching (ISELT)*, 1, 518–523.

Fianingrum, F., Novaliyosi, N., & Nindiasari, H. (2023). Kurikulum Merdeka pada Pembelajaran Matematika. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *5*(1), 132–137. https://doi.org/10.31004/edukatif.v5i1.4507

Field, A. (2018). *Discovering Statistics Using IBM SPSS Statistics. 5th Edition* (Vol. 7). Sage.

Gimenez, G., & Borras-Gene, O. (2023). Effects of a Personal Learning Environment Approach in a Master's Program for Future Teachers. *Education Sciences*, *13*(11). https://doi.org/10.3390/educsci13111129

Goodyear, P. (2005). Educational design and networked learning: Patterns, pattern languages and design practice. *Australasian Journal of Educational Technology*, *21*(1), 82–98. https://doi.org/10.14742/ajet.1367

Goodyear, P., Banks, S., Hodgson, V., & McConnell, D. (2004). Research on networked learning: An overview. In *Advances in Research on Networked Learning* (pp. 1–9). Springer. https://doi.org/10.1007/1-4020-7909-5_1

Gridos, P., Avgerinos, E., Mamona-Downs, J., & Vlachou, R. (2022b). Geometrical Figure Apprehension, Construction of Auxiliary Lines, and Multiple Solutions in

Problem Solving: Aspects of Mathematical Creativity in School Geometry. *International Journal of Science and Mathematics Education*, *20*(3), 619–636. https://doi.org/10.1007/s10763-021-10155-4

Gunawan; Suranti, N. M. F. (2020). Variations of Models and Learning Platforms for Prospective Teachers During the COVID-19 Pandemic Period. *Indonesian Journal of Teacher Education*, *1*(2), 75–94.

Haavold, P., Sriraman, B., & Lee, K.-H. (2020). Creativity in Mathematics Education. In S. Lerman (Ed.), *Encyclopedia of Mathematics Education* (pp. 145–154). Springer International Publishing. https://doi.org/10.1007/978-3-030-15789-0_33

Hadiyanti, N. F. D., Hobri, Prihandoko, A. C., Susanto, Murtikusuma, R. P., Khasanah, N., & Maharani, P. (2021). Development of mathematics e-module with STEM-collaborative project based learning to improve mathematical literacy ability of vocational high school students. *Journal of Physics: Conference Series*, *1839*(1). https://doi.org/10.1088/1742-6596/1839/1/012031

Han, J., Kelley, T., & Knowles, J. G. (2021). Factors Influencing Student STEM Learning: Self-Efficacy and Outcome Expectancy, 21st Century Skills, and Career Awareness. *Journal for STEM Education Research*, *4*(2), 117–137. https://doi.org/10.1007/s41979-021-00053-3

Harrison, M. (2018). Space as a tool for analysis: Examining digital learning spaces. *Open Praxis*, *10*(1), 17. https://doi.org/10.5944/openpraxis.10.1.782

Hassoubah, Z. (2008). *Mengasah Pikiran Kreatif dan Kritis.* Nuansa.

Hayati, R., Prima, W., Wulandari, S., Yunita, A. P., Mulyati, A., & Azmi, K. (2023). Model Pembelajaran STEAM (Science, Techonology, Engineering, Art, and Math) dalam Pembelajaran Matematika Sekolah Dasar: Pembelajaran Berdiferensiasi. *EDUKATIF : JURNAL ILMU PENDIDIKAN*, *5*(6), 2591–2603. https://doi.org/10.31004/edukatif.v5i6.5723

Haylock, D. W. (1987). A Framework for Assessing Mathematical Creativity in Schoolchildren. *Educational Studies in Mathematics*, *18*(1), 59–74. http://www.jstor.org/stable/3482505

Hidayat, P. W., & Widjajanti, D. B. (2018). Analisis kemampuan berpikir kreatif dan minat belajar siswa dalam mengerjakan soal open ended dengan pendekatan CTL. *Phytagoras: Jurnal Pendidikan Matematika*, *13*(1).

Hill-Cunningham, P. R., Mott, M. S., & Hunt, A. (2018). Facilitating an Elementary Engineering Design Process Module. *School Science and Mathematics*, *118*(1–2), 53–60. https://doi.org/10.1111/ssm.12259

Hmelo-Silver, C. E., Duncan, R. G., & Chinn, C. A. (2007). Scaffolding and achievement in problem-based and inquiry learning: A response to Kirschner, Sweller, and Clark (2006). In *Educational Psychologist* (Vol. 42, Issue 2, pp. 99–107). Routledge. https://doi.org/10.1080/00461520701263368

Holec, H. (1981). *Autonomy and Foreign Language Learning*. Oxford/New York: Pergamon Press.

Hwang, G.-J., Lai, C.-L., & Wang, S.-Y. (2015). Seamless flipped learning: a mobile technology-enhanced flipped classroom with effective learning strategies. *Journal of Computers in Education*, *2*(4), 449–473. https://doi.org/10.1007/s40692-015-0043-0

Ihsan, H. (2015). Validitas Isi Alat Ukur Penelitian Konsep dan Panduan Penilaianya. *PEDAGOGIA : Jurnal Ilmu Pendidikan*, *13*(2).

Ismail, I., Permanasari, A., & Setiawan, W. (2016). Efektivitas virtual lab berbasis STEM dalam meningkatkan literasi sains siswa dengan perbedaan gender. *Jurnal Inovasi Pendidikan IPA*, *2*(2), 190. https://doi.org/10.21831/jipi.v2i2.8570

Ismara, L., & Suratman, D. (2016). Kemampuan berpikir kreatif matematis siswa dalam menyelesaikan soal open ended di SMP. *Jurnal Pendidikan dan Pembelajaran*, *6*(9), 1–8. https://doi.org/10.26418/jppk.v6i9.21696

Istiningsih, A., Mawardi, M., & Permata, H. K. I. (2019). Peningkatan keterampilan berpikir kreatif melalui penerapan model pembelajaran mind mapping. *Edukasi: Jurnal Penelitian Dan Artikel Pendidikan*, *11*(1), 1–16. https://doi.org/10.31603/edukasi.v11i1.2676

ITEA. (2007). *Standards for technological literacy : content for the study of technology*. International Technology Education Association.

James, J., & Richard, T. (2003). *Interaction Effects in MultipleRegression*. Sage University Paper.

Jia, X., Li, W., & Cao, L. (2019). The role of metacognitive components in creative thinking. In *Frontiers in Psychology* (Vol. 10, Issue OCT). Frontiers Media S.A. https://doi.org/10.3389/fpsyg.2019.02404

Johnson, B., Zimmermann, T., & Bird, C. (2019). The effect of work environments on productivity and satisfaction of software engineers. *IEEE Transactions on Software Engineering*, 47(4), 736–757. https://doi.org/10.1109/TSE.2019.2903053

Johnson, E. (2014). *CTL Contextual Teaching & Learning*. Kaifa Learning.

Kartikasari, I. A., Usodo, B., & Riyadi. (2022). The Effectiveness Open-Ended learning and Creative Problem Solving Models to Teach Creative Thinking Skills. *Pegem Egitim ve Ogretim Dergisi*, *12*(4), 29–38. https://doi.org/10.47750/pegegog.12.04.04

Kattou, M., Kontoyianni, K., Pitta-Pantazi, D., & Christou, C. (2013). Connecting mathematical creativity to mathematical ability. *ZDM - International Journal on Mathematics Education*, *45*(2), 167–181. https://doi.org/10.1007/s11858-012-0467-1

KBBI Online, K. (2023, May 12). *KBBI Online*. Https://Kbbi.Kemdikbud.Go.Id/.

Kelley, T. R., & Knowles, J. G. (2016). A conceptual framework for integrated STEM education. *International Journal of STEM Education*, *3*(1). https://doi.org/10.1186/s40594-016-0046-z

Kennedy, T. J., & Odell, M. R. L. (2014). Engaging Students In STEM Education. *Science Education International*, *25*(3), 246–258.

Khabiri, M., & Lavasani, M. (2012). A collaborative approach to autonomy: Does it improve EFL learners' oral proficiency? *World Applied Sciences Journal*, *20*(9), 1293–1299. https://doi.org/10.5829/idosi.wasj.2012.20.09.194

Kim, B. H., & Kim, J. (2016). Development and validation of evaluation indicators for teaching competency in STEAM education in Korea. *Eurasia Journal of Mathematics, Science and Technology Education*, *12*(7), 1909–1924. https://doi.org/10.12973/eurasia.2016.1537a

Kivunja, C. (2014). Innovative Pedagogies in Higher Education to Become Effective Teachers of 21st Century Skills: Unpacking the Learning and Innovations Skills Domain of the New Learning Paradigm. *International Journal of Higher Education*, *3*(4). https://doi.org/10.5430/ijhe.v3n4p37

Kolb, D. A. (1984). *Experiential Learning: Experience As The Source Of Learning And Development Learning Sustainability View project How You Learn Is How You Live View project*. Prentice Hall.Inc. http://www.learningfromexperience.com/images/uploads/process-of-experiential-learning.pdf!

Kurniawan, H., & Susanti, E. (2021). *Pembelajaran Matematika dengan STEM (Science, Technology, Engineering, Mathematic)*. Deepublish.

Kusuma, J. W., & Hamidah, H. (2020). Perbandingan Hasil Belajar Matematika Dengan Penggunaan Platform Whatsapp Group Dan Webinar Zoom Dalam Pembelajaran Jarak Jauh Pada Masa Pandemik Covid 19. *JIPMat*, *5*(1). https://doi.org/10.26877/jipmat.v5i1.5942

Kuswana, W. S. (2013). Taksonomi Berpikir (A. Fauzia. *Remaja Rosdakarya*.

Lane, S. (2016). Effective Online Discussion Forums as a Legal Learning Space. *American Journal of Educational Research*, *4*(5), 392–396. https://doi.org/10.12691/education-4-5-5

Lee, Y., & Choi, J. (2011). A review of online course dropout research: Implications for practice and future research. In *Educational Technology Research and Development* (Vol. 59, Issue 5, pp. 593–618). https://doi.org/10.1007/s11423-010-9177-y

León, J., Núñez, J. L., & Liew, J. (2014). Self-determination and STEM education: Effects of autonomy, motivation, and self-regulated learning on high school math achievement. *Learning and Individual Differences*, *43*, 156–163. https://doi.org/10.1016/j.lindif.2015.08.017

Lestari, I. F. (2019). Pendekatan Science, Technology, Engineering, and Mathematics (STEM) untuk Meningkatkan Kemampuan Pemecahan Masalah Fisika Siswa pada Konsep Tekanan Hidrostatis. *Jurnal Pendidikan Universitas Garut*. www.journal.uniga.ac.id

Lin, M. H., Chen, H. C., & Liu, K. S. (2017). A study of the effects of digital learning on learning motivation and learning outcome. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(7), 3553–3564. https://doi.org/10.12973/eurasia.2017.00744a

Littlewood, W. (1996). *"AUTONOMY": AN ANATOMY AND A FRAMEWORK* (Vol. 24, Issue 4).

Lou, S. J., Liu, Y. H., Shih, R. C., & Tseng, K. H. (2011). The senior high school students' learning behavioral model of STEM in PBL. *International Journal of Technology and Design Education*, *21*(2), 161–183. https://doi.org/10.1007/s10798-010-9112-x

Luritawaty, I. P. (2019). Pengembangan Kemampuan Komunikasi Matematik melalui Pembelajaran Take and Give. *Mosharafa: Jurnal Pendidikan Matematika*, *8*(2), 239–248.

Marciniak, R., & Rivera, C. C. (2021). A system of indicators for the quality assessment of didactic materials in online education. *International Review of Research in Open and Distributed Learning*, 22. https://doi.org/10.19173/irrodl.v22i1.5064

Margot, K. C., & Kettler, T. (2019). Teachers' perception of STEM integration and education: a systematic literature review. In *International Journal of STEM Education* (Vol. 6, Issue 1). Springer. https://doi.org/10.1186/s40594-018-0151-2

Marrelli, A. F., Tondora, J., & Hoge, M. A. (2005). Strategies for developing competency models. *Administration and Policy in Mental Health*, *32*(5–6), 533–561. https://doi.org/10.1007/s10488-005-3264-0

Maxwell, J. A. (2012). *Designing a qualitative study*. In B. S. T. D. H. M. Lee (Ed.), *The SAGE handbook of qualitative research* (pp. 213–232). SAGE Publications.

McDonald, C. (2016). STEM education: A review of the contribution of the disciplines of science, technology, engineering, and mathematics. *Science Education International*, *27*(4), 530–569. https://doi.org/10.33828/sei.v27.i4.6

Milaturrahmah, N., Mardiyana, M., & Pramudya, I. (2017). Mathematics learning process with science, technology, engineering, mathematics (STEM) approach in Indonesia. *Journal of Physics: Conference Series*, 895(1), 12030. https://doi.org/10.1088/1742-6596/895/1/012030

Milford, T. M. (2016). Multiple Regression and Beyond: An Introduction to Multiple Regression and Structural Equation Modeling. *Journal of Educational Measurement*, *53*(2), 248–250. https://doi.org/10.1111/jedm.12108

Moore, & Greenberg, B. (2009). *Introduction to the Practice of Statistics Sixth Edition* (9th ed.). W.H. Freeman and Company.

Moore, T. J., Glancy, A. W., Tank, K. M., Kersten, J. A., Smith, K. A., & Stohlmann, M. S. (2014). A Framework for Quality K-12 Engineering Education: Research and Development. *Journal of Pre-College Engineering Education Research (J-PEER)*, *4*(1). https://doi.org/10.7771/2157-9288.1069

Moore-Russo, D., Wilsey, J., Grabowski, J., & Bampton, T. M. (2015). Perceptions of online learning spaces and their incorporation in mathematics teacher education. *Contemporary Issues in Technology and Teacher Education*, *15*(3), 283–317. https://www.learntechlib.org/primary/p/149952/

Munandar, U. (2012). *Pengembangan Kreativitas Anak Berbakat*. Rineca Cipta.

Niu, W., Cheng, L., Duan, D., & Zhang, Q. (2022). Impact of Perceived Supportive Learning Environment on Mathematical Achievement: The Mediating Roles of Autonomous Self-Regulation and Creative Thinking. *Frontiers in Psychology*, *12*. https://doi.org/10.3389/fpsyg.2021.781594

Novalia, R., Sobar, H., Ismaya, R., Marini, A., & Sumantri, M. S. (2021). Effect of the Missouri Mathematics Project model on mathematical creativity. *Journal of Physics: Conference Series*, *1869*(1). https://doi.org/10.1088/1742-6596/1869/1/012126

Nurhidayat, M. F., & Asikin, M. (2019). Bahan Ajar Berbasis STEM dalam Pembelajaran Matematika: Potensi dan Metode Pengembangan. *PRISMA, Prosiding Seminar Nasional Matematika*, *4*, 298–302. https://journal.unnes.ac.id/sju/index.php/prisma/

Nyoni, J. (2013). The viral nature of massive open online courses (MOOCs) in open and distance learning: Discourses of quality, mediation and control. *Mediterranean Journal of Social Sciences*, *4*(3), 665–672. https://doi.org/10.5901/mjss.2013.v4n3p665

OECD. (2019). Programme for international student assessment (PISA) results from PISA 2018. *Oecd*, 1–10. https://www.oecd-ilibrary.org/education/pisa-2018-results-volume-iii_bd69f805-en%0Ahttps://www.oecd-ilibrary.org//sites/bd69f805-en/index.html?itemId=/content/component/bd69f805-en#fig86

Padri, M., & Cicilia, Y. (2020). Kompetensi Bahasa dan Kompetensi Komunikatif Peserta Didik. *Instructional Development Journal (IDJ*, *1*, 49–54. http://ejournal.uin-suska.ac.id/index.php/IDJ

Permendikbud RISTEK Nomor 7 Tahun 2022 Tentang Standar Isi Pada Pendidikan Anak Usia Dini, Jenjang Pendidikan Dasar, Dan Jenjang Pendidikan Menengah, Pub. L. No. 7 (2022).

Prahmana, R. C. I., & Kusumah, Y. S. (2016). The Hypothetical Learning Trajectory on Research in Mathematics Education Using Research-Based Learning. *Pedagogika*, *123*(3), 42–54. https://doi.org/10.15823/p.2016.32

Priyanto, D., & Dharin, A. (2021). Students Creativity Development Model and Its Implementation in Indonesian Islamic Elementary School. *Pegem Egitim ve Ogretim Dergisi*, *11*(3), 81–87. https://doi.org/10.14527/pegegog.2021.00

Radziwill, N. (2018). The Fourth Industrial Revolution: Klaus Schwab. 2016. World Economic Forum, Geneva, Switzerland. 184 pages. *The Fourth Industrial Revolution: Klaus Schwab. 2016. World Economic Forum, Geneva, Switzerland. 184 Pages*, *25*(2), 108–109. https://doi.org/10.1080/10686967.2018.1436355

Riawati, E., Rosadi, K. I., & Mahluddin, M. (2022). Penerapan pembelajaran Science Technology Engineering and Mathematics (STEM) dalam meningkatkan keaktifan belajar anak usia dini. *Journal of Educational Research*, 1(2), 273–298. https://doi.org/10.31004/jer.v1i2.141

Riduwan. (2012). *Skala pengukuran variabel-variabel penelitian* (9th ed., Vol. 9). Alfabeta.

Roberts, A., & Cantu, D. (2012). Applying STEM instructional strategies to design and technology curriculum. *PATT 26 Conference Proceedings*, 13–22. https://ep.liu.se/en/conference-article.aspx?Article_No=13&issue=73&series=

Roch Asih, Dali S. Naga, & Muljadi Muljadi. (2021). Hubungan Antara Kemandirian Belajar dan Tanggung Jawab Belajar Terhadap Hasil Belajar Siswa (Studi Korelasional pada Mata Pelajaran Pendidikan Agama Buddha di SMA Dharmaputra Tangerang). *Dhammavicaya : Jurnal Pengkajian Dhamma*, *5*(1), 52–64. https://doi.org/10.47861/dv.v5i1.44

Rodger W. Bybee. (2013). *The Case for STEM Education: Challenges and Opportunities*. NSTA Press Book.

Rogers, S. E. (2019). Review of Bower, M. (2017). Design of Technology-Enhanced Learning: Integrating Research and Practice. Bingly, UK: Emerald Publishing Limited. *TechTrends*, *63*(1), 96–97. https://doi.org/10.1007/s11528-018-0340-3

Rusman. (2014). Model-model Pembelajaran Mengembangkan Profesionalisme Guru. Jakarta: Raja Grafindo Persada. *Model-Model Pembelajaran Mengembangkan Profesionalisme Guru. Jakarta: Raja Grafindo Persada.* https://doi.org/10.35316/edupedia.v3i1.317

Salonen, A., Hartikainen-Ahia, A., Hense, J., Scheersoi, A., & Keinonen, T. (2017). Secondary school students' perceptions of working life skills in science-related careers. *International Journal of Science Education, 39*(10), 1339–1352. https://doi.org/10.1080/09500693.2017.1330575

Santrock, J. (2016). *Essential of Life – Span Development*. Mc Graw-Hill.

Schleicher, A. (2019). *PISA 2018: Insights and interpretations*. OECD Publishing.

Sengil-akar, S., & Yetkin-ozdemir, I. E. (2020). International Journal of Mathematical Education in Investigation of mathematical collective creativity of gifted middle school students during model- eliciting activities : the case of the quilt problem. *International Journal of Mathematical Education in Science and Technology*, *0*(0), 1–27. https://doi.org/10.1080/0020739X.2020.1768311

Shahali, E. H. M., Halim, L., Rasul, M. S., Osman, K., & Zulkifeli, M. A. (2017). STEM learning through engineering design: Impact on middle secondary students' interest towards STEM. *Eurasia Journal of Mathematics, Science and Technology Education*, *13*(5), 1189–1211. https://doi.org/10.12973/eurasia.2017.00667a

Shankar, S., & Robinson, K. A. (2024). Comparing relations among autonomy support, motivation, and academic success across face-to-face and pandemic online STEM learning environments. *Learning and Individual Differences*, *113*, 102469. https://doi.org/10.1016/J.LINDIF.2024.102469

Siller, H. S., & Ahmad, S. (2024). Analyzing the impact of collaborative learning approach on grade six students' mathematics achievement and attitude towards mathemat. *Eurasia Journal of Mathematics, Science and Technology Education*, *20*(2). https://doi.org/10.29333/ejmste/14153

Simon, M. A. (2017). Explicating mathematical concept and mathematicalconception as theoretical constructs for mathematics education research. *Educational Studies in Mathematics*, *94*(2), 117–137. https://doi.org/10.1007/s10649-016-9728-1

Sirajudin, N., Suratno, J., & Pamuti. (2021a). Developing creativity through STEM education. *Journal of Physics: Conference Series*, *1806*(1). https://doi.org/10.1088/1742-6596/1806/1/012211

Steinberg, R. (2013). A Mathematically Creative Four-Year-Old—What Do We Learn from Him? *Creative Education*, *04*(07), 23–32. https://doi.org/10.4236/ce.2013.47a1004

Suciati, W. (2016). *Nasehat Mengembangkan Kecerdasan Emosional dan Kemandirian Belajar Agar Sukses. Bandung: CV Rasi*.

Sudarma, M. (2016). *Mengembangkan keterampilan berpikir kreatif*. Rajawali Pers.

Sugiyono. (2015). *Metode penelitian pendidikan: Pendekatan kuantitatif, kualitatif, dan R&D*. Alfabeta.

Sulistiawati, S., Suryadi, D., & Fatimah, S. (2015). Desain Didaktis Penalaran Matematis untuk Mengatasi Kesulitan Belajar Siswa SMP pada Luas dan Volume Limas. *Kreano, Jurnal Matematika Kreatif-Inovatif*, *6*(2), 135. https://doi.org/10.15294/kreano.v6i2.4833

Sumarmo, U. (2013). Berpikir dan Disposisi matematik serta Pembelajarannya. *Bandung: UPI*.

Supardi, U. S. (2015). Peran berpikir kreatif dalam proses pembelajaran matematika. *Formatif: Jurnal Ilmiah Pendidikan MIPA*, 2(3), 248–262. https://doi.org/10.30998/formatif.v2i3.107

Surya, M. (2015). *Strategi Kognitif dalam Proses Pembelajaran.* Alfabeta.

Suryaningsih, A., Cahaya, I. M. E., & Poerwati, C. E. (2023). Implementasi Model Pembelajaran Quantum Learning Berbasis Steam terhadap Kemampuan Pemecahan Masalah. *Jurnal Obsesi : Jurnal Pendidikan Anak Usia Dini*, *7*(2), 1887–1896. https://doi.org/10.31004/obsesi.v7i2.4299

Suzanna, Y., & Maulida, I. (2021). Higher order thinking skills (HOTS) profiles students on the material of three variable linear equation systems. *Proceedings of the 2nd International Conference on Science, Technology, and Modern Society (ICSTMS 2020)*, 362–366. https://doi.org/10.2991/assehr.k.210909.081

Tan, A.-L., Teo, T. W., Choy, B. H., & Ong, Y. S. (2019). The S-T-E-M Quartet. *Innovation and Education*, *1*(1), 1–14. https://doi.org/10.1186/s42862-019-0005-x

Thiagarajan. (1976a). Instructional development for training teachers of exceptional children: A sourcebook. *Journal of School Psychology*, *14*(1), 75. https://doi.org/10.1016/0022-4405(76)90066-2

Thiagarajan. (1976b). Instructional development for training teachers of exceptional children: A sourcebook. *Journal of School Psychology*, *14*(1), 75. https://doi.org/10.1016/0022-4405(76)90066-2

Thibaut, L., Ceuppens, S., De Loof, H., De Meester, J., Goovaerts, L., Struyf, A., Boeve-de Pauw, J., Dehaene, W., Deprez, J., De Cock, M., Hellinckx, L., Knipprath, H., Langie, G., Struyven, K., Van de Velde, D., Van Petegem, P., & Depaepe, F. (2018). Integrated STEM Education: A Systematic Review of Instructional Practices in Secondary Education. *European Journal of STEM Education*, *3*(1). https://doi.org/10.20897/ejsteme/85525

Thomas, A., & Edson, A. J. (2019).Contemporary issues in technology and teacher education. *Contemporary Issues in Technology and Teacher Education*, *19*(3), 351–372. Retrieved from https://citejournal.s3.amazonaws.com/wp-content/uploads/v19i3mathematics1.pdf

Tomlinson, C. A., Moon, T. R., & Imbeau, M. B. (2013). Assessment and student success in a differentiated classroom. *ASCD.* Retrieved from https://www.ascd.org/books/assessment-and-student-success-in-a-differentiated-classroom

Tsai, C. H., Rodriguez, G. R., Li, N., Robert, J., Serpi, A., & Carroll, J. M. (2020). Experiencing the Transition to Remote Teaching and Learning during the COVID-19 Pandemic. *Interaction Design and Architecture(s)*, *46*, 70–87. https://doi.org/10.55612/s-5002-046-004

Tseng, K. H., Chang, C. C., Lou, S. J., & Chen, W. P. (2013). Attitudes towards science, technology, engineering and mathematics (STEM) in a project-based learning (PjBL) environment. *International Journal of Technology and Design Education*, *23*(1), 87–102. https://doi.org/10.1007/s10798-011-9160-x

Tubb, A. L., Cropley, D. H., Marrone, R. L., Patston, T., & Kaufman, J. C. (2020). The development of mathematical creativity across high school : Increasing , decreasing , or both ? *Thinking Skills and Creativity*, *35*(February), 100634. https://doi.org/10.1016/j.tsc.2020.100634

Ünal, S., Çeliköz, N., & Sarı, İ. (2017). EFL Proficiency in Language Learning and Learner Autonomy Perceptions of Turkish Learners. *Journal of Education and Practice*, *8*(11). www.iiste.org

Utami, R. P., Probosari, R. M., & Fatmawati, U. (2015). Pengaruh model pembelajaran project based learning berbantu Instagram terhadap kemampuan berpikir kreatif siswa kelas X SMA Negeri 8 Surakarta. *Bio-Pedagogi: Jurnal Pembelajaran Biologi*, *4*(1), 47–52. https://doi.org/10.20961/bio-pedagogi.v4i1.1923

Utami, R. W., Endaryono, B. T., & Djuhartono, T. (2020). Meningkatkan kemampuan berpikir kreatif matematis siswa melalui pendekatan open-ended. *Faktor: Jurnal Ilmiah Kependidikan*, *7*(1), 43–48. https://doi.org/10.30998/fjik.v7i1.5328

Vigotsky, L. (1978). *Mind in society: The development of higher psychological processes.* Harvard University Press

Waluya, S. B., Ardiansyah, A. S., & Asikin, M. (2021a). *CB-BL model (challenge based on blended learning) for mathematical creativity CB-BL model (challenge based on blended learning) for mathematical creativity*. https://doi.org/10.1088/1742-6596/1918/4/042065

Waluya, S. B., Ardiansyah, A. S., & Asikin, M. (2021b). Effect of the Missouri Mathematics Project model on mathematical creativity Effect of the Missouri Mathematics Project model on mathematical creativity. *Journal of Physics: Conference Series*. https://doi.org/10.1088/1742-6596/1869/1/012126

Wang, J. (2019). Application of blending learning based on network learning space in teaching design of digital art. *International Journal of Emerging Technologies in Learning*, *14*(3), 177–189. https://doi.org/10.3991/ijet.v14i03.10107

Warfield, J., Wood, T., & Lehman, J. D. (2005). Autonomy, beliefs and the learning of elementary mathematics teachers. *Teaching and Teacher Education*, *21*(4), 439–456. https://doi.org/10.1016/j.tate.2005.01.011

Weinstein, N., Brown, K. W., & Ryan, R. M. (2009). A multi-method examination of the effects of mindfulness on stress attribution, coping, and emotional well-being. *Journal of Research in Personality*, *43*(3), 374–385. https://doi.org/10.1016/j.jrp.2008.12.008

Widana, I. W., & Septiari, K. L. (2021). Kemampuan berpikir kreatif dan hasil belajar matematika siswa menggunakan model pembelajaran Project-Based Learning berbasis pendekatan STEM. *Jurnal Elemen*, *7*(1), 209–220. https://doi.org/10.23887/jel.v7i1.3031

Widodo, S., Turmudi, T., & Rosjanuardi, R. (2021). Autonomy and creative thinking skills of prospective elementary school teacher students in learning mathematics with science phenomena assisted by the learning management system. *International Journal of Learning, Teaching and Educational Research*, *20*(8), 160–175. https://doi.org/10.26803/ijlter.20.8.10

Winarni, J., Zubaidah, S., & H, S. K. (2016). STEM: Apa, mengapa, dan bagaimana. *Prosiding Seminar Nasional Pendidikan IPA Pascasarjana UM*, 1, 976–984. https://doi.org/10.17509/jpa.v4i1.27207

Wong, S. C. (2020). Competency Definitions, Development and Assessment: A Brief Review. *International Journal of Academic Research in Progressive Education and Development*, *9*, 95–114. https://doi.org/10.6007/IJARPED/v9-i3/8223

Wu, Y. (2018). Online Learning Space and Wisdom Teaching. *MATEC Web of Conferences*, *176*, 1–3. https://doi.org/10.1051/matecconf/201817602026

Yaniawati, P., Maat, S. M., Supianti, I. I., & Fisher, D. (2022). Mathematics mobile blended learning development: Student-oriented high order thinking skill learning. *European Journal of Educational Research*, *11*(1), 69–81. https://doi.org/10.12973/EU-JER.11.1.69

Yasmin, M., & Naseem, F. (2019). Collaborative Learning and Learner Autonomy: Beliefs, Practices and Prospects in Pakistani Engineering Universities. *IEEE Access*, *7*, 71493–71499. https://doi.org/10.1109/ACCESS.2019.2918756

Yayuk, E., Purwanto, As'Ari, A. R., & Subanji. (2020). Primary school students' creative thinking skills in mathematics problem solving. *European Journal of Educational Research*, *9*(3), 1281–1295. https://doi.org/10.12973/eu-jer.9.3.1281

Yin, R. K. (2018). *Case Study Research and Applications: Design and Methods* (6th ed.). SAGE Publications

Yin, R. K., Calvin, Y., & Mali, G. (2017). *Case Study Research and Applications: Design and Methods*. Sage Publication. https://doi.org/http://dx.doi.org/10.1563

Yuliardi, R., & Dahlan, J. A. (2022). STEM Highlights: Principles, Frameworks and Implementation Strategies in Improving Scientific Literacy. *International Journal on Emerging Mathematics Education*, *6*(2), 119. https://doi.org/10.12928/ijeme.v6i2.19812

Yuliardi, R., Juandi, D., Maizora, D. S., & Mahpudin, A. (2020). *Analisis Keterampilan Representasi Matematis Siswa melalui Pembelajaran Matematika berbasis Aplikasi Android*. http://journal.unnes.ac.id/nju/index.php/kreano

Yuliardi, R., Kusumah, Y. S., Juandi, D., & Nurjanah. (2024). Development of a STEM-based Digital Learning Space to Increase Students' Mathematical Creativity in Borderless Classrooms. *AIP Conference Proceedings*, *3220*(1). https://doi.org/10.1063/5.0234850

Zhe, W. (2009). *Sebuah studi kontras dari otonomi pelajar Cina & Barat. Bahasa Asing AS-China* (Vol. 7, Issue 12, pp. 9–11).

Zubaidah, S. (2017). Keterampilan abad ke-21: Keterampilan yang diajarkan melalui pembelajaran. *ResearchGate*, Juni, 3. https://doi.org/10.13140/RG.2.2.12277.17120