

THE IMPLEMENTATION OF STEM PROJECT-BASED LEARNING  
ON STUDENT'S STEM LITERACY AND PROBLEM-SOLVING  
SKILLS

RESEARCH PAPER

Submitted as Requirement to Obtain Degree of *Sarjana Pendidikan* in  
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INTERNATIONAL PROGRAM ON SCIENCE EDUCATION

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SHEET OF LEGITIMATION

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## DECLARATION

I do hereby declare that the research paper entitled “The Implementation of STEM Project-Based Learning on Student’s STEM Literacy And Problem-Solving Skills” and all of its content is genuinely pure result of my original ideas, effort, research, and work. This is not copied or plagiarized inappropriate ways from other papers. The opinions and findings of others which is contained in this research paper have been quoted and referenced based on scientific code of conduct and accordance with ethical science that applies in scholarly society. This declaration is created truthfully and consciously. When it is found an infringement towards scientific ethics, or if there is a claim of any others towards the authenticity of this research paper, hence I am willing to responsible and accept academics sanctions correspond to applicable rules.

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## PREFACE

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This research paper entitled “The Implementation of STEM Project-Based Learning on Student’s STEM Literacy And Problem-Solving Skills” is submitted to fulfill one of the requirements in accomplishing S1 Degree in International Program on Science Education FPMIPA Universitas Pendidikan Indonesia.

The author hopes this research paper can provide benefits and insight for the readers, also improve the quality of education. Aamiin.

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Bandung, August 2020

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# **THE IMPLEMENTATION OF STEM PROJECT-BASED LEARNING ON STUDENT'S STEM LITERACY AND PROBLEM-SOLVING SKILLS**

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## **ABSTRACT**

Indonesia is threatened with natural disasters during this COVID-19 pandemic as it is located on the Pacific Ring of Fire. Future generations should be prepared to provide STEM literacy related to solving a real-world problem using their integrated science and knowledge of technology, engineering, and mathematics. The need to produce better educational quality leads us to STEM Project-based Learning. Therefore, this research investigated the effect of STEM Project-Based Learning on student's STEM Literacy and Problem-Solving Skills. For the research, 30 7th grade students from one of junior high school in Bandung were chosen. The pre-experiment method with one group pre-test and post-test design in the form of multiple-choice and essay questions were used as the data collection tools. The data analysis showed the N-Gain score is 0.47 which categorized as medium improvement in STEM Literacy. Technology literacy was the highest improvement, while the Mathematical Literacy in the lowest. Nonetheless, the Problem-Solving skills N-gain score is 0.73 which categorized as high improvement. The highest improvement is in Idea-Finding, while the Fact-Finding on the lowest. Therefore, STEM Project-Based Learning is recommended to improve students' STEM Literacy and Problem Solving Skills since they had the experience to use their integrated knowledge in solving a real-world problem.

Keywords: STEM Project-Based Learning, STEM Literacy, Problem Solving Skills, Earth layer and disaster

# **IMPLEMENTASI PEMBELAJARAN STEM BERBASIS PROYEK DI LITERASI STEM SISWA DAN KETERAMPILAN PEMECAHAN MASALAH SISWA**

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## **ABSTRAK**

Indonesia juga terancam oleh bencana alam selama pandemi COVID-19 ini karena terletak di Lingkaran Api Pasifik. Generasi mendatang harus dipersiapkan untuk menggunakan literasi STEM terkait dengan pemecahan masalah dunia nyata menggunakan sains dan pengetahuan terintegrasi tentang teknologi, rekayasa, dan matematika. Kebutuhan untuk menghasilkan kualitas pendidikan yang lebih baik mengarahkan kita pada Pembelajaran Berbasis Proyek STEM. Oleh karena itu, penelitian ini menyelidiki pengaruh Pembelajaran Berbasis Proyek STEM terhadap Literasi STEM dan Keterampilan Pemecahan Masalah siswa. Untuk penelitian ini dipilih 30 siswa kelas VII dari salah satu SMP di Bandung. Metode pre-eksperimen dengan rancangan one group pre-test dan post-test berupa soal pilihan ganda dan uraian digunakan sebagai alat pengumpulan data. Analisis data menunjukkan nilai N-Gain sebesar 0,47 yang dikategorikan sebagai peningkatan literasi STEM sedang. Literasi teknologi mengalami peningkatan tertinggi, sedangkan literasi matematika mengalami peningkatan terendah. Meskipun demikian, skor N-gain keterampilan Pemecahan Masalah adalah 0,73 yang dikategorikan sebagai peningkatan tinggi. Peningkatan tertinggi pada Pencarian Ide, sedangkan Pencarian Fakta pada yang terendah. Oleh karena itu, Pembelajaran Berbasis Proyek STEM direkomendasikan untuk meningkatkan Literasi STEM dan Keterampilan Pemecahan Masalah siswa karena mereka memiliki pengalaman untuk menggunakan pengetahuan terintegrasi mereka dalam memecahkan masalah dunia nyata.

Kata kunci: Pembelajaran Berbasis Proyek STEM, Literasi STEM, Keterampilan Pemecahan Masalah, Lapisan Bumi dan Bencana Alam

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## REFERENCES

- Afriana, J., Permanasari, A., & Fitriani, A. (2016). Project based learning integrated to stem to enhance elementary school's students scientific literacy. *Jurnal Pendidikan IPA Indonesia*, 5(2), 261–267. <https://doi.org/10.15294/jpii.v5i2.5493>
- Apriyani, R., Ramalis, T. R., & Suwarma, I. R. (2019). Analyzing Student's Problem Solving Abilities of Direct Current Electricity in STEM-based Learning. *Journal of Science Learning*, 2(3), 85–91. <https://doi.org/10.17509/jsl.v2i3.17559>
- Ardianto, D., Firman, H., & Permanasari, A. (2019). *What is Science , Technology , Engineering , Mathematics ( STEM ) Literacy ?* 253(Aes 2018), 381–384.
- Ardianto, D., Permanasari, A., Firman, H., & Ramalis, T. R. (2019). Analyzing higher education students' understanding of earthquake-resistant buildings on stem learning. *Journal of Engineering Science and Technology*, 14, 47–57.
- Arisanti, W. O. L., Sopandi, W., & Widodo, A. (2016). Analisis Penguasaan Konsep dan Keterampilan Berpikir Kreatif Siswa SD Melalui Project Based Learning. *EduHumaniora Jurnal Pendidikan Dasar Kampus Cibiru*, 8(1), 82-95. <https://doi.org/10.17509/eh.v8i1.5125>
- Arreola, N. J., & Reiter-Palmon, R. (2016). The effect of problem construction creativity on solution creativity across multiple everyday problems. *Psychology of Aesthetics, Creativity, and the Arts*, 10(3), 287–295. <https://doi.org/10.1037/a0040389>.
- Balka, D. (2011). Standards of mathematical practice and STEM. *The Math-Science Connector*, 6–8.
- Bencana, B. N. P. (2020). *Data Informasi Bencana Indonesia (DIBI)*. Retrieved from <https://bnpb.cloud/dibi/>
- Benedek, M., Nordtvedt, N., Jauk, E., Koschmieder, C., Pretsch, J., Krammer, G., & Neubauer, A. C. (2016). Assessment of creativity evaluation skills: A psychometric investigation in prospective teachers. *Thinking Skills and Creativity*, 21, 75–84. <https://doi.org/10.1016/j.tsc.2016.05.007>

- Berkant, H. G., & Eren, İ. (2013). Investigating problem solving skills of students of primary school math teaching department in terms of some variables. *International Journal of Social Science*, 6(3), 1021-1041.
- Bhakti, Y. B., Astuti, I. A. D., Okyanida, I. Y., Asih, D. A. S., Marhento, G., Leonard, L., & Yusro, A. C. (2020). Integrated STEM Project Based Learning Implementation to Improve Student Science Process Skills. *Journal of Physics: Conference Series*, 1464(1). <https://doi.org/10.1088/1742-6596/1464/1/012016>
- BigRentz. (2020). *How Earthquake-Proof Buildings Are Designed*. Retrieved from <https://www.bigrentz.com/blog/earthquake-proof-buildings>
- Blumenfeld, P. C., Soloway, E., Marx, R. W., Krajcik, J. S., Guzdial, M., & Palincsar, A. (1991). Motivating project-based learning: Sustaining the doing, supporting the learning. *Educational psychologist*, 26(3-4), 369-398.
- Bybee, B. (2010). Advancing STEM education: A 2020 vision. *Technology and engineering teacher*, 70(1), 30-35.
- Capraro, M. M., & Jones, M. (2013). Interdisciplinary STEM project-based learning. *STEM Project-Based Learning an Integrated Science, Technology, Engineering, and Mathematics (STEM) Approach*, 51–58. [https://doi.org/10.1007/978-94-6209-143-6\\_6](https://doi.org/10.1007/978-94-6209-143-6_6)
- Capraro, R. M., & Slough, S. W. (2013). Why PBL? why STEM? why now? an introduction to STEM project-based learning: An integrated science, technology, engineering, and mathematics (STEM) approach. *STEM Project-Based Learning an Integrated Science, Technology, Engineering, and Mathematics (STEM) Approach*, 1–5. [https://doi.org/10.1007/978-94-6209-143-6\\_1](https://doi.org/10.1007/978-94-6209-143-6_1)
- Chang, C. Y., & Weng, Y. H. (2002). An exploratory study on students' problem-solving ability in earth science. *International Journal of Science Education*, 24(5), 441–451. <https://doi.org/10.1080/09500690110066502>
- Chiang, C. L., & Lee, H. (2016). The Effect of Project-Based Learning on Learning Motivation and Problem-Solving Ability of Vocational High

- School Students. *International Journal of Information and Education Technology*, 6(9), 709–712. <https://doi.org/10.7763/ijiet.2016.v6.779>
- CNNIndonesia.com. (2019, 4 Oktober). BMKG: Jepang Sudah Wajibkan Bangunan Anti Gempa Sejak 1990. Retrieved from <https://www.cnnindonesia.com/teknologi/20191003112012-199-436323/bmkg-jepang-sudah-wajibkan-bangunan-anti-gempa-sejak-1990>
- Cohen, L., & Manion, L. (2001). *Research Methods in Education* 5th Edition Rotledge Falmer, New York.
- Cropley, A. (2006). In praise of convergent thinking. *Creativity research journal*, 18(3), 391-404.
- De Castella, K., Byrne, D., & Covington, M. (2013). Unmotivated or motivated to fail? A cross-cultural study of achievement motivation, fear of failure, and student disengagement. *Journal of Educational Psychology*, 105(3), 861–880. <https://doi.org/10.1037/a0032464>
- Deniz, M. (2004). Investigation of the relation between decision making self-esteem, decision making style and problem solving skills of university students. *Eurasian Journal of Educational Research (EJER)*, (15).
- Earthquaketrack. (2020). *Recent Earthquakes Near Indonesia*. Retrieved from <https://earthquaketrack.com/p/indonesia/recent>
- Fitriani, A., Zubaidah, S., Susilo, H., & Al Muhdhar, M. H. I. (2020). The effects of integrated problem-based learning, predict, observe, explain on problem-solving skills and self-efficacy. *Eurasian Journal of Educational Research*, 2020(85), 45–64. <https://doi.org/10.14689/ejer.2020.85.3>
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (1993). *How to design and evaluate research in education* (Vol. 7). New York: McGraw-Hill.
- Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). Internal validity. *How to design and evaluate research in education*. New York: McGraw-Hill, 166-83.
- Grohman, M., Wodniecka, Z., & KŁsak, M. (2006). Divergent thinking and evaluation skills: Do they always go together? *Journal of Creative Behavior*, 40(2), 125–145. <https://doi.org/10.1002/j.2162-6057.2006.tb01269.x>

- Gustiani, I., Widodo, A., & Suwarma, I. R. (2017). Development and validation of science, technology, engineering and mathematics (STEM) based instructional material. *AIP Conference Proceedings*, 1848(May). <https://doi.org/10.1063/1.4983969>
- Guthrie, J. T., Schafer, W. D., Von Secker, C., & Alban, T. (2000). Contributions of instructional practices to reading achievement in a statewide improvement program. *Journal of Educational Research*, 93(4), 211–225. <https://doi.org/10.1080/00220670009598710>
- Hake, R. R. (1998). Interactive-engagement versus traditional methods: A six-thousand-student survey of mechanics test data for introductory physics courses. *American journal of Physics*, 66(1), 64-74.
- Han, S., Capraro, R., & Capraro, M. M. (2015). How Science, Technology, Engineering, and Mathematics (Stem) Project-Based Learning (Pbl) Affects High, Middle, and Low Achievers Differently: the Impact of Student Factors on Achievement. *International Journal of Science and Mathematics Education*, 13(5), 1089–1113. <https://doi.org/10.1007/s10763-014-9526-0>
- Hanif, S., Wijaya, A. F. C., & Winarno, N. (2019). Enhancing Students' Creativity through STEM Project-Based Learning. *Journal of Science Learning*, 2(2), 50. <https://doi.org/10.17509/jsl.v2i2.13271>
- Hasanah, U. (2018). *Pengaruh Pembelajaran Berbasis Stem Terhadap Literasi Teknologi Dan Kreativitas Produk Siswa Sma Pada Materi Pencemaran Lingkungan* (Doctoral dissertation, Universitas Pendidikan Indonesia).
- Heffernan, K., & Teufel, S. (2018). Identifying problems and solutions in scientific text. *Scientometrics*, 116(2), 1367–1382. <https://doi.org/10.1007/s11192-018-2718-6>
- Henderson, C. (2005). Strategies for development of student problem solving. Skills in the High School Physics Classroom. *Am. J. Physics*, 59(10), 891-897.
- Jackson, C. D., & Mohr-Schroeder, M. J. (2018). Increasing Stem Literacy Via an Informal Learning Environment. *Journal of STEM Teacher Education*, 53(1). <https://doi.org/10.30707/jste53.1jackson>

- Johnson, S. D., Dixon, R., Daugherty, J., & Lawanto, O. (2011). General versus specific intellectual competencies: The question of learning transfer. In *Fostering human development through engineering and technology education* (pp. 55-71). Brill Sense.
- Kavrayici, C. (2020). Communication Skills and Classroom Management Competency: The Mediating Role of Problem-Solving Skills. *Journal of Teacher Education and Educators*, 9(1), 125–137.
- Kemendikbud. (2017). Silabus Satuan Pendidikan Kelas IX. *Model Silabus Mata Pelajaran Sekolah Menengah Pertama/Madrasah Tsanawiyah (SMP/MTs)*, 1–78.
- Kemendikbud. (2020). *Inilah Perubahan Kebijakan Pendidikan Selama Masa Pandemi Covid-19*. Retrieved from <https://setkab.go.id/inilah-perubahan-kebijakan-pendidikan-selama-masa-pandemi-covid-19/>
- Khaerunnisa, N. F. (2017). *Pengaruh Pembelajaran Berbasis Stem Terhadap Keterampilan Desain Produk Pada Materi Ekosistem* (Doctoral dissertation, Universitas Pendidikan Indonesia)
- Liu, Y. H., Lou, S. J., & Lou, S. J. (2014). The investigation of STEM self-efficacy and professional commitment to engineering among female high school students. *South African Journal of Education*, 34(2), 1–15. <https://doi.org/10.15700/201412071216>
- Lim, K. Y. T., & Widodo, A. (2018). Microclimate studies in a STEM-based curriculum using open source hardware and software. Quezon City, Philippines: Foundation for Information Technology Education and Development.
- Lou, S. J., Chou, Y. C., Shih, R. C., & Chung, C. C. (2017). A study of creativity in CaC 2 steamship-derived STEM project-based learning. *Eurasia Journal of Mathematics, Science and Technology Education*, 13(6), 2387–2404. <https://doi.org/10.12973/EURASIA.2017.01231A>
- Lou, S. J., Tsai, H. Y., Tseng, K. H., & Shih, R. C. (2014). Effects of implementing STEM-I project-based learning activities for female high school students. *International Journal of Distance Education Technologies*, 12(1), 52–73. <https://doi.org/10.4018/ijdet.2014010104>

- Luthfiyani, S. H., Widodo, A., & Rochintaniawati, D. (2019). Pengaruh Pembelajaran Biologi Berbasis STEM terhadap Literasi Teknologi dan Keterampilan Pengambilan Keputusan Siswa SMA. *Assimilation: Indonesian Journal of Biology Education*, 2(2), 77. <https://doi.org/10.17509/aijbe.v2i2.19251>
- Mawson, W. B. (2013). Emergent technological literacy: What do children bring to school? *International Journal of Technology and Design Education*, 23(2), 443–453. <https://doi.org/10.1007/s10798-011-9188-y>
- Maydeu-Olivares, A., & D’Zurilla, T. J. (1997). The factor structure of the problem solving inventory. *European Journal of Psychological Assessment*, 13(3), 206–215. <https://doi.org/10.1027/1015-5759.13.3.206>
- Mayasari, T., Kadarohman, A., Rusdiana, D., & Kaniawati, I. (2016). Apakah Model Pembelajaran Problem Based Learning Dan Project Based Learning Mampu Melatihkan Keterampilan Abad 21? *Jurnal Pendidikan Fisika Dan Keilmuan (JPFK)*, 2(1), 48. <https://doi.org/10.25273/jpfk.v2i1.24>
- National Assessment Governing Board. (2010). Technology and engineering literacy framework for the 2014 NAEP.
- National Information Centre of Earthquake Engineering. (2004). Guidelines for Earthquake Resistant Non-Engineered Construction. Retrieved Desember 9, 2018, from [https://www.nicee.org/IAEE\\_English.php](https://www.nicee.org/IAEE_English.php).
- National Research Council. (2012). *A framework for K-12 science education: Practices, crosscutting concepts, and core ideas*. National Academies Press.
- Netwong, T. (2018). Development of Problem Solving Skills by Integration Learning Following STEM Education for Higher Education. *International Journal of Information and Education Technology*, 8(9), 639–643. <https://doi.org/10.18178/ijiet.2018.8.9.1114>
- Nuraziza, R., & Suwarma, I. R. (2018). Menggali Keterampilan Creative Problem Solving Yang Dimiliki Siswa Smp Melalui Pembelajaran Ipa Berbasis Stem. *WaPFI (Wahana Pendidikan Fisika)*, 3(1), 55. <https://doi.org/10.17509/wapfi.v3i1.10941>

- Nurlaely, N., Permanasari, A., & Riandi, R. (2017). Student's STEM Literacy in Biotechnology Learning at Junior High School. *Journal of Physics: Conference Series*, 895(1). <https://doi.org/10.1088/1742-6596/895/1/012155>
- OECD. (2012). PISA 2012 Field Trial Problem Solving Framework. *Oecd*, 1–47.
- OECD. (2019). PISA 2018 Results: Combined Executive Summaries, Volume I, II & III. Retrieved from [https://www.oecd.org/pisa/Combined\\_Executive\\_Summaries\\_PISA\\_2018.pdf](https://www.oecd.org/pisa/Combined_Executive_Summaries_PISA_2018.pdf)
- Persaud-Sharma, D. (2012). Pedagogical methods to promote STEM literacy. *International Journal of Science, Mathematics and Technology Learning*, 19(4), 1–12. <https://doi.org/10.18848/2327-7971/cgp/v19i04/49014>
- Prima, E. C., Oktaviani, T. D., & Sholihin, H. (2018). STEM learning on electricity using arduino-phet based experiment to improve 8th grade students' STEM literacy. *Journal of Physics: Conference Series*, 1013(1). <https://doi.org/10.1088/1742-6596/1013/1/012030>
- Rustam E, S., Sidabutar, D. R., & Edy, S. (2017). Improving Learning Activity and Students ' Problem Solving Skill through Problem Based Learning ( PBL ) in Junior High School. *International Journal of Sciences: Basic and Applied Research (IJSBAR)*, 33(2), 321–331. <http://gssrr.org/index.php?journal=JournalOfBasicAndApplied>
- Sari, P. M. (2018). *Pengaruh Pembelajaran Berbasis Stem Terhadap Literasi Teknologi Dan Kemampuan Merancang Teknologi Alternatif Pada Materi Pencemaran Lingkungan* (Doctoral dissertation, Universitas Pendidikan Indonesia).
- Schlegel, R. J., Chu, S. L., Chen, K., Deurmeyer, E., Christy, A. G., & Quek, F. (2019). Making in the classroom: Longitudinal evidence of increases in self-efficacy and STEM possible selves over time. *Computers & Education*, 142, 103637. <https://doi.org/10.1016/j.compedu.2019.103637>
- Sintema, E. J. (2020). Effect of COVID-19 on the performance of grade 12 students: Implications for STEM education. *Eurasia Journal of*

- Mathematics, Science and Technology Education, 16(7), 1–6.  
<https://doi.org/10.29333/EJMSTE/7893>
- Sudjana, N. (2005). Metode Statistika Edisi keenam. *Bandung: PT. Tarsito.*
- Suryawati, E., Osman, K., & Meerah, T. S. M. (2010). The effectiveness of RANGKA contextual teaching and learning on student's problem solving skills and scientific attitude. *Procedia - Social and Behavioral Sciences*, 9, 1717–1721. <https://doi.org/10.1016/j.sbspro.2010.12.389>
- Tati, T., Firman, H., & Riandi, R. (2017). The Effect of STEM Learning through the Project of Designing Boat Model toward Student STEM Literacy. *Journal of Physics: Conference Series*, 895(1).  
<https://doi.org/10.1088/1742-6596/895/1/012157>
- Treffinger, D. J., Isaksen, S. G., & Stead-Dorval, K. B. (2005). *Creative problem solving: An introduction*. Prufrock Press Inc.
- Wahyuni, S., Indrawati, I., Sudarti, S., & Suana, W. (2017). Developing science process skills and problem-solving abilities based on outdoor learning in junior high school. *Jurnal Pendidikan IPA Indonesia*, 6(1), 165–169.  
<https://doi.org/10.15294/jpii.v6i1.6849>
- Whitten, S. & Graesser, A. C. (2003). Comprehension of text in problem solving. In J. E. Davidson & R. J. Sternberg (Eds.), *The psychology of problem solving* (pp. 207–229). New York, NY: Cambridge University Press.
- Wulandari, N. F. (2015). Jailani.(2015). Indonesian Students's Mathematics Problem Solving Skill in PISA and TIMSS. In *Proceeding of International Conference On Research, Implementation And Education of Mathematics And Sciences*.
- Yasin, A. I., Prima, E. C., & Sholihin, H. (2018). Learning Electricity using Arduino-Android based Game to Improve STEM Literacy. *Journal of Science Learning*, 1(3), 77. <https://doi.org/10.17509/jsl.v1i3.11789>
- Yenni, R., Hernani, & Widodo, A. (2017). The implementation of integrated science teaching materials based socio-scientific issues to improve students scientific literacy for environmental pollution theme. *AIP Conference Proceedings*, 1848. <https://doi.org/10.1063/1.4983970>



- Yu, K. C., Fan, S. C., & Lin, K. Y. (2015). Enhancing Students' Problem-Solving Skills Through Context-Based Learning. *International Journal of Science and Mathematics Education*, 13(6), 1377–1401. <https://doi.org/10.1007/s10763-014-9567-4>
- Yuliati, L., Riantoni, C., & Mufti, N. (2018). Problem solving skills on direct current electricity through inquiry-based learning with PhET simulations. *International Journal of Instruction*, 11(4), 123–138. <https://doi.org/10.12973/iji.2018.1149a>
- Zollman, A. (2012). Learning for STEM Literacy: STEM Literacy for Learning. *School Science and Mathematics*, 112(1), 12–19. <https://doi.org/10.1111/j.1949-8594.2012.00101.x>