PAPER CIRCUIT PROJECT-BASED STEAM LEARNING TO ENHANCE STUDENT UNDERSTANDING AND CREATIVITY

RESEARCH PAPER

Submitted as Requirement to Obtain Degree of Sarjana Pendidikan in
International Programon Science Education (IPSE) Study Program

Arranged by:

Arnie Novianti Zulkarnain
1909723

INTERNATIONAL PROGRAM ON SCIENCE EDUCATION
FACULTY OF MATHEMATICS AND SCIENCE EDUCATION
UNIVERSITAS PENDIDIKAN INDONESIA
2023

PAPER CIRCUIT PROJECT-BASED STEAM LEARNING TO ENHANCE STUDENT UNDERSTANDING AND CREATIVITY

Oleh
Arnie Novianti Zulkarnain

Sebuah skripsi yang diajukan untuk memenuhi salah satu syarat memperoleh gelar Sarjana Pendidikan pada Fakultas Pendidikan Matematika dan Ilmu Pengetahuan Alam

APPROVAL FORM FOR RESEARCH PAPER

PAPER CIRCUIT PROJECT-BASED STEAM LEARNING TO ENHANCE STUDENT UNDERSTANDING AND CREATIVITY

Approved and confirmed by:

Supervisor I

Dr. Eka Cahya Prima, S.Pd., M.T.

NIP. 199006262014041001

Supervisor II

Dr. Nanang Winarno, S.S.i., S.Pd., M.Pd.

NIP. 198403212014041001

Head of International Program on Science Education Study Program

Prof. Dr. Ida Kaniawati, M.Si.

NIP. 196807031992032001

DECLARATION

I declare that the research entitled **"Paper Circuit Project-based STEAM Learning to Enhance Student Understanding and Creativity"** has been composed personally by myself, except where otherwise stated by reference or acknowledgement. I do not plagiarize in any way that is not appropriate with applicable regulation. For the declaration, I am ready to accept the risk or sanction if there is copyright infringement found.

Bandung, August 20th, 2023

Arnie Novianti Zulkarnain
NIM. 1909723

PAPER CIRCUIT PROJECT-BASED STEAM LEARNING TO ENHANCE STUDENT UNDERSTANDING AND CREATIVITY

Arnie Novianti Zulkarnain

International Program on Science Education

arnienovianti@upi.edu

ABSTRACT

Students believed physics is one of the most difficult sciences in education and their interest in learning physics was lacking. Therefore, this study aims to enhance students' understanding and creativity in the STEAM learning system in electricity topic by creating a project (Paper Circuit) using the students' creativity at the junior high school level. Quantitative research with a pre-experimental design used as method for this study. The population is 8th grade and 9th grade (50 students adapted to the curriculum used in the school) in one of Junior Secondary School that is located in Bandung and Cimahi, Indonesia. The data is obtained through results from the pretest-posttest results standing from average of pre-test score was 57.04 and the post-test score was 76.64. The nonparametric test was tested using the Willcoxon test, for measureing student understanding. The results from e Willcoxon is .000 which the results show sig. <0.05, which means there is a significant difference pre-test and post-test. Students' creativity is obtained from Creativity Product Analysis Matrix (CPAM) and the result for project 1 as 73.71% which is categorized enough and project 2 as 83.13% which is categorized as good. Based on the result, Paper Circuit STEAM project-based learning can enhance student understanding and creativity STEAM project-based learning can be used as alternative teaching strategies in Junior Secondary School.

Keywords: Electricity, STEAM Project Based Learning, Students' Creativity, Students' Understanding.

PEMBELAJARAN STEAM BERBASIS PROYEK SIRKUIT KERTAS UNTUK MENINGKATKAN PEMAHAMAN DAN KREATIVITAS SISWA

Arnie Novianti Zulkarnain

International Program on Science Education

arnienovianti@upi.edu

ABSTRAK

Siswa percaya fisika adalah salah satu ilmu yang paling sulit dalam pendidikan dan minat mereka untuk belajar fisika kurang. Oleh karena itu, penelitian ini bertujuan untuk meningkatkan pemahaman dan kreativitas siswa dalam sistem pembelajaran STEAM pada materi kelistrikan dengan membuat proyek (sirkuit kertas) menggunakan kreativitas siswa di tingkat SMP. Penelitian kuantitatif dengan desain pre-experimental digunakan sebagai metode penelitian ini. Populasinya adalah kelas 8 dan 9 (50 siswa disesuaikan dengan kurikulum yang digunakan di sekolah) di salah satu SMP yang terletak di Bandung dan Cimahi, Indonesia. Data diperoleh melalui hasil pretest-posttest berdiri dari rata-rata skor pre-test adalah 57,04 dan skor post-test adalah 76,64. Uji nonparametrik diuji dengan menggunakan uji Willcoxon, untuk mengukur pemahaman siswa. Hasil dari Willcoxon adalah .000 yang hasilnya menunjukkan sig. < 0,05 yang berarti terdapat perbedaan yang signifikan antara pretest dan posttest. Kreativitas siswa diperoleh dari Creativity Product Analysis Matrix (CPAM) dan hasil proyek 1 sebesar 73,71% dikategorikan cukup dan proyek 2 sebesar 83,13% dikategorikan baik. Berdasarkan hasil tersebut, pembelajaran berbasis proyek kertas sirkuit dengan pembelajaran STEAM dapat meningkatkan pemahaman dan kreativitas siswa. Pembelajaran berbasis proyek STEAM dapat digunakan juga sebagai strategi pengajaran alternatif di SMP.

Kata kunci: Listrik, Pembelajaran Berbasis Proyek STEAM, Kreativitas Siswa, Pemahaman Siswa,

ACKNOWLEDGEMENT

The author praises gratitude to Allah SWT for this mercy so that the author can finish this research paper. On his occasion, the author would like to express this sincere gratitude and appreciation to the following:

1. Allah SWT, who guides me and protects me all the long way so I can finish this research paper.
2. Dr. Eka Cahya Prima, S.Pd., M.T. as the Secretary of International Program on Science Education Study Program, my student advisor, and my first supervisor who patiently guide and always approach me while writing my research paper.
3. Dr. Nanang Winarno, S.Si., S.Pd., M.Pd. as my second supervisor, for his invaluable guidance, encouragement, and the wealth of knowledge he shared during the compilation of this research paper.
4. Prof. Dr Ida Kaniawati, S.Pd., M.Si., as head of study program who has approved my research paper.
5. All IPSE Lecturer, Laborants, and Administrators, thank you for supporting, help, care, for giving knowledge to the author from the beginning of semester until finish this research paper.
6. My Mom named Jennie Verawati, SE, who always supported me and who always pray for me in every aspect of my life and finished this research paper.
7. All IPSE 2019 students who always supported, cared, and loved me, especially Rizki Maulana and Aisyah Nurul, who always helped me to give information about my research paper.
8. Winata Tegar IPSE 2020 and Sifa Pringgi IPSE 2021, who becomes friends, always helping me and giving support to me
9. All junior high schools involved in this research. Thank you for permitting for the author to conduct research. Thank you for the time and opportunity that has been given.
10. My brother named Abrar Zulkarnain, who always helping and supported me when I'm having trouble doing research or preparing this research paper
11. Last but not least, I want to thank me. I want to thank me for believing in

me, I want to thank me for doing all this hard work. I want to thank me for having no days off. I want to thank me for never quitting. I want to thank me for always being a giver and trying to give more than I receive. I want to thank me for trying to do more right than wrong and being me at all times.

PREFACE

Assalamualaikum Wr. Wb

All the praises delivered to Allah SWT for the bless, grace, and mercy so the author can finish this research paper entitled “Paper Circuit Project-based STEAM Learning to Enhance Student Understanding and Creativity”. Sholawat and Salam always delivered to our prophet Muhammad SAW, all his family, and all Muslim in the world.

This research paper becomes the final requirement to obtain degree as a Sarjana Pendidikan in the International Program on Science Education major at Universitas Pendidikan Indonesia. The author released this book still has deficiencies and still needs to be improved. Therefore, the author expects to get input on suggestion to improve the quality of this research book in the future. The writer hopes that this book can be useful for readers or people who need references, information, or knowledge from this book about science education.

Bandung, August 2023

Author

TABLE OF CONTENT

LIST OF TABLES

LIST OF FIGURES

LIST OF APPENDICES

REFERENCES

Aguilera, D., & Ortiz-Revilla, J. (2021). Stem vs. Steam education and student creativity: A systematic literature review. *Education Sciences*, *11*(7). https://doi.org/10.3390/educsci11070331

Amabile, T. M. (2012). Componential Theory of Creativity. *Harvard Business School*, 1–10.

Anderson, L. W., & Krathwohl, D. R. (Eds. . (2001). *A Taxonomy for Learning, Teaching, and Assessing*. Addison Wesley Longman, Inc.

Anwari, I., Yamada, S., Unno, M., Saito, T., Suwarma, I. R., Mutakinati, L., & Kumano, Y. (2015). Implementation of authentic learning and assessment through stem education approach to improve students' metacognitive skills. *K-12 STEM Education*, *1(3)*, 123–136.

Asghar, A., Ellington, R., Rice, E., Johnson, F., & Prime, G. . (2012). Supporting STEM Education in Secondary Science Contexts. *Interdiscip. J. Probl.-Based Learn*.

Bazler, J., & Sickle, M. V. (2017). Cases on STEAM education in practice. *IGI Global*. https://doi.org/10.4018/978-1-5225-2334-5

Besemer, S. P., & Treffinger, D. J. (1981). Analysis of Creative Products: Review and Synthesis. *The Journal of Creative Behavior*, *15*(3), 158–178. https://doi.org/10.1002/j.2162-6057.1981.tb00287.x

Boyle, J. (2021). Oceans of Inspiration: A Marine Based STEAM Project. *European Journal of STEM Education*, *6*(1), 15. https://doi.org/10.20897/ejsteme/11356

Bybee, R. W. (2010). Advancing STEM Education: A 2020 Vision. *Technology and Engineering Teacher*, 30–35.

Cao, Y., & Brizuela, B. M. (2016). High school students' representations and understandings of electric fields. *Physical Review Physics Education Research*.

Christine, V., & McDonald. (2016). STEM Education: A review of the contribution of the disciplines of science, technology, engineering and mathematics. *Science Education International*, *27*(4), 530–569.

Colucci-Gray, L., Trowsdale, J., Cooke, C. F., Davies, R., Burnard, P., & Gray, D.

S. (2017). Reviewing the potential and challenges of developing STEAM education through creative pedagogies for 21st learning. *How Can School Curricula Be Broadened Towards a More Responsive, Dynamic, and Inclusive Form of Education?*, 1–105.

Connor, A. M., Karmokar, S., & Whittington, C. (2015). From STEM to STEAM: Strategies for enhancing engineering & technology education. *International Journal of Engineering Pedagogy, 5(2),* 37 – 47. https://doi.org/doi: 10.3991/ijep.v5i2.4458

Creswell, J. W., & Creswell, J. D. (2018). Research Design, Qualitative, Quantitative, and Mixed Methods Approachs, Second Edition. In *Sage Publications*. Sage Publications.

Davies, D., Jindal-Snape, D., Collier, C., Digby, R., Hay, P., & Howe, A. (2013). Creative learning environments in education-A systematic literature review. *Thinking Skills and Creativity*, *8*(1), 80–91. https://doi.org/10.1016/j.tsc.2012.07.004

Dawes, L., & Wegerif, R. (2004). *Thinking and learning with ICT: Raising achievement in primary classrooms*.

Farwati, R., Metafisika, K., Sari, I., Sitinjak, D., Solikha, D. F., & Putra, E. E. (2021). STEM Education Dukung Merdeka Belajar (dilengkapi dengan Perangkat Pembelajaran Berbasis STEM). *DOTPLUS*. https://books.google.co.id/books?id=TeIhEAAAQBAJ&hl=id&sitesec=reviews

Fraenkel, J. R., Wallen, N. E., & Hyun, H. H. (2011). *How to Design and Evaluate Research in Education* (Issue 1). McGraw-Hill.

Hake, R. R. (1999). Analyzing change/gain scores. *American Educational Research Association's Division D*, *16*(7), 1073–1080. http://www.ncbi.nlm.nih.gov/pubmed/22025883%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:ANALYZING+CHANGE/GAIN+SCORES#0%5Cnhttp://scholar.google.com/scholar?hl=en&btnG=Search&q=intitle:Analyzing+change/gain+scores#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

Henriksen, D. (2014). Full STEAM Ahead: Creativity in Excellent STEM Teaching Practices. *STEAM Journal*, *1*(2), 1–9. https://doi.org/10.5642/steam.20140102.15

Kim, D. H., Ko, D. G., Han, M. J., & Hong, S. H. (2014). The Effects of science lessons applying STEAM education program on the creativity and interest levels of elementary students. *Journal of the Korean Association for Science Education, 34 (1),* 43–54.

Kim, S. W., Chung, Y. L., Woo, A. J., & Lee, H. J. (2012). Development of a theoretical model for STEAM education. *Journal of the Korean Association for Science Education*, *32*(2), 388–401.

King, B. . (1993). *Statistical Reasoning in Psychology and Education*. John Wiley & Son.

Kokotsaki, D., Menzies, V., & Wiggins, A. (2016). Project-based learning: A review of the literature. *Improving Schools*, *19*(3), 267–277. https://doi.org/10.1177/1365480216659733

Lee, V. R., & Recker, M. (2018). Paper Circuits: A Tangible, Low Threshold, Low Cost Entry to Computational Thinking. *TechTrends*, *62*(2), 197–203. https://doi.org/10.1007/s11528-017-0248-3

Lindberg, L., Fields, D. A., & Kafai, Y. B. (2020). STEAM Maker Education: Conceal/Reveal of Personal, Artistic and Computational Dimensions in High School Student Projects. *Frontiers in Education*, *5*(May), 1–16. https://doi.org/10.3389/feduc.2020.00051

Manika, K. P., & Prima, E. C. (2020). STEM Learning on Electricity using Arduino-Protoboard Experiment to Improve 8th Grade Students' STEM Literacy. *Proceedings of the 7th Mathematics, Science, and Computer Science Education International Seminar, MSCEIS 2019, October 2019*. https://doi.org/10.4108/eai.12-10-2019.2296437

Marshall, A. (2016). *Facilitating STEAM Learning among Children with Paper Circuit Activities*. 3–5.

Meltzer, D. E. (2002). The relationship between mathematics preparation and conceptual learning gains in physics: A possible "hidden variable" in

diagnostic pretest scores. *American Journal of Physics*, *70*(12), 1259–1268. https://doi.org/10.1119/1.1514215

Miller, J., & Knezek, G. (2013). STEAM for student engagement. *Proceedings of the SITE 2013*, 25–29.

Mulhall, P., McKittrick, B., & Gunstone, R. (2001). A Perspective on the Resolution of Confusions in the Teaching of Electricity. *Research in Science Education*.

Munandar, U. S. C. (1999). *Mengembangkan Bakat dan Kreativitas Anak Sekolah*. Gramedia Widiasarana Indonesia.

Ogunleye, J. (2018). *Creativity and innovation in STEM Education*. https://tinyurl.com/4ce4af7xOrnstein

Ozkan, G., & Topsakal, U. . (2019). Exploring the effectiveness of STEAM design processes on middle school students' creativity. *Int. J. Technol. Des. Educ*.

Perignat, E., & Katz-Buonincontro, J. (2019). STEAM in practice and research: An integrative literature review. *Thinking Skills and Creativity*, *31*, 31–43. https://doi.org/10.1016/j.tsc.2018.10.002

Permanasari, A. (2016). STEM Education: inovasi dalam pembelajaran sains. *Seminar Nasional Pendidikan Sains VI*.

Purnamasari, I., Khasanah, I., & Wahyuni, S. (2020). Digital literacy for children based on steam in family education. *Journal of Physics: Conference Series*, *1464*(1). https://doi.org/10.1088/1742-6596/1464/1/012032

Purwanto, M. N. (2009). *Prinsip-prinsip dan Teknik Evaluasi Pengajaran*. Remaja Rosdakarya.

Rahmawati, Y., Adriyawati, Utomo, E., & Mardiah, A. (2021). The integration of STEAM-project-based learning to train students critical thinking skills in science learning through electrical bell project. *Journal of Physics: Conference Series*, *2098*(1). https://doi.org/10.1088/1742-6596/2098/1/012040

Riskawati. (2018). Uji Validitas dan Reliabilitas. *Jurnal Tarbiyah: Jurnal Ilmiah Kependidikan*, *7*(1), 1–10.

Sanders, M. (2009). STEM, STEM education, STEMmania. *The Technology*

Teacher, 20–26.

Sani, A., Rochintaniawati, D., & Winarno, N. (2019). Using Brain-Based Learning to Promote Students' Concept Mastery in Learning Electric Circuit. *Journal of Science Learning*, *2*(2), 42. https://doi.org/10.17509/jsl.v2i2.13262

Shorter, M., Rogers, J., & McGhee, J. (2014). *Practical Notes on Paper Circuits*. 483–492.

Sigit, D. V., Ristanto, R. H., & Mufida, S. N. (2022). Integration of Project-Based E-Learning with STEAM: An Innovative Solution to Learn Ecological Concept. *International Journal of Instruction*, *15*(3), 23–40. https://doi.org/10.29333/iji.2022.1532a

Taylor, P. . (2016). Evaluating the beneft of the maker movement in K-12 STEM education. *International Journal of Education, Arts, and Science*, *1–22*(2). https://tinyurl.com/anksn527

Wandari, G. A., Wijaya, A. F. C., & Agustin, R. R. (2018). The Effect of STEAM-based Learning on Students' Concept Mastery and Creativity in Learning Light And Optics. *Journal of Science Learning*, *2*(1), 26. https://doi.org/10.17509/jsl.v2i1.12878

Wannapiroon, N., & Pimdee, P. (2022). Thai undergraduate science, technology, engineering, arts, and math (STEAM) creative thinking and innovation skill development: a conceptual model using a digital virtual classroom learning environment. *Education and Information Technologies*, *27*(4), 5689–5716. https://doi.org/10.1007/s10639-021-10849-w

Weibert, A., Aal, K., Wulf, V., & Masrhall, A. (2016). *Facilitating STEAM Learning among Children with Paper Circuit Activities*. McGraw-Hill.

White, D. W. (2014). What Is STEM education and why is it important? *Florida Association of Teacher Educators Journal*, 1–9.

Widodo, A. (2005). *Taksonomi Tujuan Pembelajaran*. *4*, 61–69.

Wittayakhom, N., & Piriyasurawong, P. (2020). Learning Management STEAM Model on Massive Open Online Courses Using Augmented Reality to Enhance Creativity and Innovation. *Higher Education Studies*, *10*(4), 44. https://doi.org/10.5539/hes.v10n4p44

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