

**THE USE OF DIGITAL MINDMAP TO ENHANCE STUDENTS'
COMPUTATIONAL THINKING IN LEARNING
GLOBAL WARMING**

RESEARCH PAPER

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



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

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**THE USE OF DIGITAL MIND MAP TO ENHANCE STUDENTS'
COMPUTATIONAL THINKING IN LEARNING
GLOBAL WARMING**

Skripsi ini diajukan untuk memenuhi salah satu syarat
memperoleh gelar Sarjana Pendidikan
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**THE USE OF DIGITAL MIND MAP TO ENHANCE STUDENTS'
COMPUTATIONAL THINKING IN LEARNING
GLOBAL WARMING**

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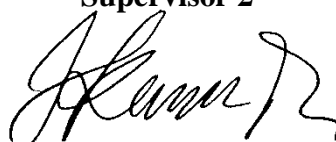
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DECLARATION

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COMPUTATIONAL THINKING IN LEARNING
GLOBAL WARMING**

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ABSTRACT

Computational thinking is considered to be one of the 21st century's important skills as it leads to the ability to solve complex problems. Indonesian students' low score in PISA indicates their low ability in computational thinking, as the test items are using complex problems. One of the expected ways to enhance students' computational thinking across curriculum is by creating digital mind map. This study was aimed to enhance students' computational thinking in learning global warming and to see the correlation between computational thinking score and mind map score. The quasi-experiment with pre-post-test design in the form of written essay test was used as the data collection tool. The participants consisted of 30 students of seventh grade from a private junior high school in Bandung, Indonesia. The result indicates that there was a significant difference in students' computational thinking between experimental and control classes with a significant value (2-tailed) of 0.006 and sig. $\alpha = 0.05$. The eta squared value showed that the experimental class had a large effect size on the computational thinking skills compared to the control class that had a medium effect size. It was also found that decomposition is the most enhanced computational thinking aspect in both of the classes. The correlation between computational thinking score and mind mapping scores was a weak, positive, and non-significant correlation. Despite low correlation yet the significant difference, digital mind mapping can be considered an alternative to enhance students' computational thinking, followed by some recommendations for further study.

Keywords: *Students computational thinking, Digital Mind Mapping, Global warming topic.*

**PENGGUNAAN MIND MAP DIGITAL UNTUK MENINGKATKAN
KEMAMPUAN BERPIKIR KOMPUTASI SISWA DALAM
MEMPELAJARI TOPIK PEMANASAN GLOBAL**

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ABSTRAK

Kemampuan berpikir komputasional dianggap sebagai salah satu keterampilan penting abad ke-21 karena mengarah pada kemampuan untuk memecahkan masalah yang bersifat kompleks. Rendahnya nilai PISA siswa Indonesia menunjukkan rendahnya kemampuan berpikir komputasional mereka, karena soal-soal tesnya menggunakan permasalahan yang kompleks. Salah satu cara yang diharapkan untuk dapat meningkatkan kemampuan berpikir komputasional siswa adalah dengan membuat mind map digital. Penelitian ini bertujuan untuk meningkatkan kemampuan berpikir komputasional siswa dalam pembelajaran pemanasan global dan untuk melihat ada tidaknya hubungan positif antara skor berpikir komputasional dan skor mind map. Penelitian ini menggunakan metode quasi-eksperimental dengan desain pre-post-test berupa tes esai tertulis yang digunakan sebagai alat pengumpulan data. Partisipan terdiri dari 30 siswa kelas tujuh dari sebuah SMP swasta di Bandung, Indonesia. Hasil penelitian menunjukkan bahwa terdapat perbedaan yang signifikan dalam berpikir komputasional siswa antara kelas eksperimen dan kelas kontrol dengan nilai signifikansi 0,006 dan sig. $\alpha = 0.05$. Nilai eta squared menunjukkan bahwa kelas eksperimen memiliki ukuran efek yang besar terhadap kemampuan berpikir komputasional dibandingkan dengan kelas kontrol yang memiliki ukuran efek sedang. Ditemukan juga bahwa dekomposisi adalah aspek kemampuan berpikir komputasional yang paling meningkat di kedua kelas. Korelasi antara skor kemampuan berpikir komputasional dan skor mind map digital adalah korelasi yang lemah, positif, dan tidak signifikan. Terlepas dari rendahnya korelasi namun perbedaan yang signifikan, mind map digital dapat dianggap sebagai alternatif untuk meningkatkan kemampuan berpikir komputasional siswa, diikuti dengan beberapa rekomendasi untuk studi lebih lanjut.

Kata kunci: *Pemikiran komputasional siswa, Digital Mind Mapping, Pemanasan global.*

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REFERENCES

- Al-Saqqa, S., Al-Sayyed, R., Al Shraideh, M., Obaidah, M. A., & Balawi, S. (2014). How technology affects our life: The case of mobile free minutes in Jordan. *Life Science Journal*, *11*(7), 417–423.
- Ali, S. H., Carr, P. A., & Ruit, K. G. (2016). Validity and Reliability of Scores Obtained on Multiple-Choice Questions: Why Functioning Distractors Matter. *Journal of the Scholarship of Teaching and Learning*, *16*(1), 1–14. <https://doi.org/10.14434/josotl.v16i1.19106>
- Anthony, K. R. N., Kline, D. I., Diaz-Pulido, G., Dove, S., & Hoegh-Guldberg, O. (2008). Ocean acidification causes bleaching and productivity loss in coral reef builders. *Proceedings of the National Academy of Sciences of the United States of America*, *105*(45), 17442–17446. <https://doi.org/10.1073/pnas.0804478105>
- Argina, A., & Desi, M. (2017). Indonesia PISA Result: What Factors and What Should Be Fixed? *The 1st Education and Language International Conference Proceedings Center for International Language Development of Unissula*, *1*(1), 69–79.
- Arikunto, S. (2013). *Prosedur Penelitian Suatu Pendekatan Praktik*. Rineka Cipta.
- Asmara, A. (2020). Study on Computational Thinking as Problem-solving Skill: Comparison Based on Students Mindset in Engineering and Social Science. *ArXiv Preprint ArXiv:2007.04060*.
- Baksh, Z., Potphode, S., & Shrivastava, N. P. (2016). A Study of Mind Mapping in Education and Teaching through the Technology. *International Journal of Innovative Research in Computer and Communication Engineering*, *4*(11), 19254–19259. <https://doi.org/10.15680/IJIRCCE.2016.0411041>
- Barrington, L., Casner-Lotto, J., & Wright, M. (2006). *Are they really ready to work? Employers' perspectives on the basic knowledge and applied skills of new entrants to the 21st century workforce*. Partnership for 21st Century Skills.
- Brooks, J. (2019). *Computational Thinking through Classroom Assessment*. Tech-Based Teaching. <https://medium.com/tech-based-teaching/computational-thinking-through-classroom-assessment-6b8299ea0fb6>
- Brown, J. S., Kuhn, D., Wissner, R., Power, E., & Schnell, R. (2004). Quantification of Sources of Variation and Accuracy of Sequence Discrimination in a Replicated Microarray Experiment. *Biotechnology*, *36*(2), 324–332.
- Buzan, T. (1993). *The mind map book: How to use radiant thinking to maximize your brain's untapped potential*. Penguin Group.

- Case, M., Ardiansyah, F., & Spector, E. (2007). Climate Change in Indonesia: Implications for Humans and Nature. In *World Wide Fund for Nature, UK (WWF)*.
- Clark, D. B., & Sengupta, P. (2017). Reconceptualizing games for integrating computational thinking and science as practice: collaborative agent-based disciplinarily-integrated games. *Interactive Learning Environments*, 28(3), 328–346. <https://doi.org/10.1080/10494820.2019.1636071>
- Cohen, Manion, & M. (2017). *Research Methods in Education*. Routledge Taylor & Francis Group.
- Creswell, J. W. (2008). *Educational Research: Planning, Conducting, and Evaluating Quantitative Research*. Pearson Education Ltd.
- Csizmadia, A., Curzon, P., Dorling, M., Humphreys, S., Ng, T., Selby, C., & Woollard, J. (2015). Computational thinking A guide for teachers. In *Computing At School*.
- Debbag, M., Cukurbasi, B., & Fidan, M. (2020). Use of Digital Mind Maps in Technology Education: A Pilot Study with Pre-Service Science Teachers. *Informatics in Education*, 47–68.
- Debbag, Murat, Cukurbasi, B., & Fidan, M. (2021). Use of Digital Mind Maps in Technology Education: A Pilot Study with Pre-Service Science Teachers. *Informatics in Education*, 20(1), 47–68. <https://doi.org/10.15388/infedu.2021.03>
- Devita N, Y., Agustiningih, A., & Surya Hutama, F. (2018). The Effect of Mind Mapping Learning Strategy in Science to the Fifth Grade Students' Learning Outcomes. *Pancaran Pendidikan*, 7(3), 13–20. <https://doi.org/10.25037/pancaran.v7i3.186>
- Dong, Y., Cateté, V., Jocius, R., Lytle, N., Barnes, T., Albert, J., Joshi, D., Robinson, R., & Andrews, A. (2019). Prada: A practical model for integrating computational thinking in K-12 education. *SIGCSE 2019 - Proceedings of the 50th ACM Technical Symposium on Computer Science Education*, 906–912. <https://doi.org/10.1145/3287324.3287431>
- Faenkel, J. R., Wallen, N. E., & Hyun, H. H. (2012). *How to Design and Evaluate Research in Education*. McGraw Hill.
- Fakhriyah, F., Masfuah, S., & Mardapi, D. (2019). Developing scientific literacy-based teaching materials to improve students' computational thinking skills. *Jurnal Pendidikan IPA Indonesia*, 8(4), 482–491. <https://doi.org/10.15294/jpii.v8i4.19259>
- Fatimah, R. R. (2020). *Gamification Classroom for Enhancing Students' Computational Thinking in Learning Respiratory System Topic* (Vol. 2017, Issue 1). Universitas Pendidikan Indonesia.
- Fawzy, S., Osman, A. I., Doran, J., & Rooney, D. W. (2020). Strategies for mitigation of climate change: a review. *Environmental Chemistry Letters*,

- 18(6), 2069–2094. <https://doi.org/10.1007/s10311-020-01059-w>
- Haseski, H. I., Ilic, U., & Tugtekin, U. (2018). Defining a New 21st Century Skill-Computational Thinking: Concepts and Trends. *International Education Studies*, 11(4), 29. <https://doi.org/10.5539/ies.v11n4p29>
- Hunsaker, E. (2018). Computational Thinking. In A. Ottenbreit-Leftwich & R. Kimmons (Eds.), *The K-12 Educational Technology Handbook*. EdTech.
- Irwandi, H., Rosid, M. S., & Mart, T. (2021). The effects of ENSO, climate change and human activities on the water level of Lake Toba, Indonesia: a critical literature review. *Geoscience Letters*, 8(1). <https://doi.org/10.1186/s40562-021-00191-x>
- Jbeili, I. M. A. (2013a). The Impact of Digital Mind Maps on Science Achievement among Sixth Grade Students in Saudi Arabia. *Procedia - Social and Behavioral Sciences*, 103, 1078–1087. <https://doi.org/10.1016/j.sbspro.2013.10.435>
- Jbeili, I. M. A. (2013b). The Impact of Digital Mind Maps on Science Achievement among Sixth Grade Students in Saudi Arabia. *Procedia - Social and Behavioral Sciences*, 103, 1078–1087. <https://doi.org/10.1016/j.sbspro.2013.10.435>
- Kalelioglu, F., Gulbahar, Y., & Kukul, V. (2016). A Framework for Computational Thinking Based on a Systematic Research Review. *Baltic Journal of Modern Computing*, 4(3), 583.
- Kaplan, R. M., & Saccuzzo, D. P. (2013). *Psychological Assessment and Theory: Creating and Using Psychological Test*. Wadsworth Cengage Learning.
- Karim, R. A., & Mustapha, R. (2020). Students' Perception on the Use of Digital Mind Map to Stimulate Creativity and Critical Thinking in ESL Writing Course. *Universal Journal of Educational Research*, 8(12A), 7596–7606. <https://doi.org/10.13189/ujer.2020.082545>
- Kwauk, C., & Winthrop, R. (2021). *Unleashing the Creativity of Teacher and Students to Combat Climate Change: An Opportunity for Global Leadership*. Brookings.
- Lachner, A., Ly, K. T., & Nückles, M. (2018). Providing Written or Oral Explanations? Differential Effects of the Modality of Explaining on Students' Conceptual Learning and Transfer. *Journal of Experimental Education*, 86(3), 344–361. <https://doi.org/10.1080/00220973.2017.1363691>
- Laisa, Z. (2019). Primary School Teachers and Learning Media in the Era of Education 4.0. *Journal of Physics: Conference Series*, 1387.
- Lee, T. Y., Mauriello, M. L., Ahn, J., & Bederson, B. B. (2014). CTArcade: Computational thinking with games in school age children. *International Journal of Child-Computer Interaction*, 2(1), 26–33. <https://doi.org/10.1016/j.ijcci.2014.06.003>

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- Lindsay, R., & Dahlman, L. (2021, March 21). *Climate Change: Global Temperature*. <https://www.climate.gov/news-features/understanding-climate/climate-change-global-temperature>
- Liu, Y., Zhao, G., Ma, G., & Bo, Y. (2014). The Effect of Mind Mapping on Teaching and Learning : . *Stand J.Edu.Res.Essay*, 2(4), 17–31.
- Malallah, S., & Weese, J. L. (2020). The effects of mind maps on computational thinking. *ASEE Annual Conference and Exposition, Conference Proceedings, 2020-June*(June). <https://doi.org/10.18260/1-2--35312>
- Mcclelland, K., & Grata, L. (2018). A review of the importance of computational thinking in K-12. *The Tenth International Conference on Mobile, Hybrid, and On-Line Learning*, 32–34.
- McCoog, I. J. (2008). *21st Century Teaching and Learning*. ERIC.
- MECRT. (2017). *Mata Pelajaran Ilmu Pengetahuan Alam*. Kementerian Pendidikan dan Kebudayaan.
- Mishra, P., & Yadav, A. (2013). Of Art and Algorithm: Rethinking Technology & Creativity in the 21st Century. *TechTrends*, 57(3), 10–14. <https://doi.org/10.1007/s11528-013-0668-7>
- Mohaghegh, D. M., & McCauley, M. (2016). *International journal of computer science and information technologies (IJCSIT)*. 7(3), 1524–1530. <https://unitec.researchbank.ac.nz/handle/10652/3422>
- Mufidah, I. (2018). *Menyelesaikan Bebras Task Ditinjau Dari* (Issue November). Universitas Islam Negeri Sunan Ampel Surabaya.
- Mustapha, R., Abdul Rahim, Z. L., & Azman, M. N. A. (2014). Exploring the Problems Faced by Technical School Students in Learning Engineering Course. *Journal of Engineering Science and Technology*, 9, 690–701.
- Papadakis, S., Kalogiannakis, M., & Zaranis, N. (2016). Developing fundamental programming concepts and computational thinking with ScratchJr in preschool education: A case study. *International Journal of Mobile Learning and Organisation*, 10(3), 187–202. <https://doi.org/10.1504/IJMLO.2016.077867>
- Park, S. Y., & Jeon, Y. (2015). Teachers' perception on Computational Thinking in Science Practices. *International Journal of Education and Information Technologies*, 9, 180–185.
- Qualls, J. A., & Sherrell, L. B. (2010). Why Computational Thinking Should be Integrated into the Curriculum. *Journal of Computing Science in Colleges*, 25(5), 66–71.
- Raja, R., & Nagasubramani, P. C. (2018). Impact of modern technology in education. *Journal of Applied and Advanced Research*, 3(S1), 33. <https://doi.org/10.21839/jaar.2018.v3is1.165>

- Rezapour-Nasrabad, R. (2019). Mind map learning technique: An educational interactive approach. *International Journal of Pharmaceutical Research*, 11(1), 1593–1597.
- Rich, P. J., & Hodges, C. (2017). Emerging Research, Practice, and Policy on Computational Thinking. *Educational Communications and Technology: Issues and Innovations*.
- Rosidin, U., & Suyatna, A. (2017). Teachers and Students Knowledge about Global Warming: a Study in Smoke Disaster Area of Indonesia. *International Journal of Environmental & Science Education*, 777–785.
- Ross, K. N. (2005). Sample Design for Educational Survey Research. In *Quantitative Research Methods in Education Planning*. IIEP UNESCO.
- Ryerson, M.-H. (2015). *Scoring Rubric for Mind Maps*. 28.
- Saad, A. (2020). Students' computational thinking skill through cooperative learning based on hands-on, inquiry-based, and student-centric learning approaches. *Universal Journal of Educational Research*, 8(1), 290–296. <https://doi.org/10.13189/ujer.2020.080135>
- Safar, A. H., Jafer, Y. J., & Alqadiri, M. A. (2014). Mind Maps as Facilitative Tools in Science Education. *College Students Journal*, 48(4), 629–647.
- Schober, P., & Schwarte, L. A. (2018). Correlation coefficients: Appropriate use and interpretation. *Anesthesia and Analgesia*, 126(5), 1763–1768. <https://doi.org/10.1213/ANE.0000000000002864>
- Sulistiyo, M. A. S., & Wijaya, A. (2020). The effectiveness of inquiry-based learning on computational thinking skills and self-efficacy of high school students. *Journal of Physics: Conference Series*, 1581(1). <https://doi.org/10.1088/1742-6596/1581/1/012046>
- Suryansyah, A., Kastolani, W., & Somantri, L. (2021). Scientific Thinking Skills in Solving Global Warming Problems. *IOP Conference Series: Earth and Environmental Science*, 683.
- Swanson, H., Anton, G., Bain, C., Horn, M., & Wilensky, U. (2019). Computational Thinking Education. In *Computational Thinking Education*. Springer Singapore. <https://doi.org/10.1007/978-981-13-6528-7>
- Toedte, R. J., & Aydeniz, M. (2015). Computational thinking and impacts on K-12 science education. *Proceedings - Frontiers in Education Conference, FIE, 2015*(April 2018). <https://doi.org/10.1109/FIE.2015.7344239>
- Voogt, J., Fisser, P., Good, J., Mishra, P., & Yadav, A. (2015). Computational thinking in compulsory education: Towards an agenda for research and practice. *Education and Information Technologies*, 20(4), 715–728. <https://doi.org/10.1007/s10639-015-9412-6>
- Voskoglou, M. G., & Buckley, S. (2012). *Problem Solving and Computational Thinking in a Learning Environment*. 36(4), 28–46.

<http://arxiv.org/abs/1212.0750>

- Wang, S. H. (2020). Instruction Design and Strategy of Concept Mapping. *5th International Conference on Economics, Management, Law, and Education*, 111–120.
- White, H., & Sabarwal, S. (2014). Quasi-Experimental Design and Methods. In *Methodological Briefs: Impact Evaluation 8*. UNICEF Office of Research.
- Wijaya, A., Chrysolite, H., Ge, M., Wibowo, C. K., & Pradana, A. (2017). HOW CAN INDONESIA ACHIEVE ITS CLIMATE CHANGE MITIGATION GOAL? AN ANALYSIS OF POTENTIAL EMISSIONS REDUCTIONS FROM ENERGY AND LAND-USE POLICIES. *World Resources Institute, September*. [https://wri-indonesia.org/sites/default/files/WRI Layout Paper OCN v7.pdf](https://wri-indonesia.org/sites/default/files/WRI%20Layout%20Paper%20OCN%20v7.pdf)
- Wing, J. M. (2006). View Point: Computational Thinking. *Communication of the ACM*, 49(3), 33–35.
- Yadav, A., Good, J., Voogt, J., & Fisser, P. (2017). Computational thinking as an emerging competence domain. *Technical and Vocational Education and Training*, 23(January), 1051–1067. https://doi.org/10.1007/978-3-319-41713-4_49
- Yadav, A., Hong, H., & Stephenson, C. (2016). Computational Thinking for All: Pedagogical Approaches to Embedding 21st Century Problem Solving in K-12 Classrooms. *TechTrends*, 60(6), 565–568. <https://doi.org/10.1007/s11528-016-0087-7>
- Zulaiha, R. (2008). *Analisis Soal Secara Manual [Manually Question Analysis]*. Puspendik.