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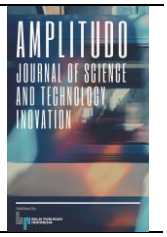

The Potential of Developing Computational Thinking Approach-Based Physics Learning Media as a Means of Increasing Students' Problem-Solving Ability

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Abstract: A computational thinking approach is an approach to thinking and reasoning by computer scientists. Computational thinking skills can be adopted as an approach to solving a problem and analyzing the solution. The computational thinking approach is not limited to computer science but can also be applied to other disciplines through problem-solving. The computational thinking approach has been integrated into various instruments and learning media. The purpose of this research is to see the potential of the computational thinking approach to be integrated into learning media to improve problem-solving skills and to discuss the integration of computational thinking in various learning tools and media. This research method uses literature studies with 6 international articles as the main source from scopus.com and 19 articles as supporting articles from scholar.google.com. The results of the study show that the computational thinking approach has the potential to be integrated into various learning tools and media as a means of increasing problem-solving skills.

Keywords: Computational thinking; Learning media; Physics; Problem solving

Introduction

Physics is a branch of science that discusses energy and material entities, along with the relationship between the two (Gunawan et al., 2015). Physics as part of science cannot be separated from process skills to solve problems in natural phenomena (Noviatika et al., 2019). If taught through constructive and participatory learning, physics has the potential to lead students to have good problem-solving skills (Rahmawati and Ika, 2020). The problem-solving ability itself is a very important part of learning because, during the learning process and its completion, it is possible for students to gain experience using the knowledge they already have (Abdani et al., 2018).

Research by Utami et al. (2017), Citra et al. (2021), and Rahmalia (2021) found that students still have low problem-solving skills. According to PISA (The Program for International Student Assessment), in 2018, Indonesia occupies the 74th position out of 79 countries in the fields of mathematics, science, and literacy (Schleicher, 2018). These results indicate that the problem-solving ability of students in Indonesia is still quite low.

The low ability of students to solve problems is caused by teachers who do not facilitate learning through appropriate methods and strategies so students are less accustomed to solving problems in the learning process (Selviyana et al., 2022). The teacher only carries out the learning process using conventional and less participatory methods. In physics subjects, more students are given the task of writing down formulas without being given a detailed explanation regarding a concept. Therefore, teachers need to plan and carry out learning processes that can improve students' problem-solving abilities. One way is to integrate learning with a computational thinking approach.

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According to Ifriliya et al. (2022), computational thinking encompasses a process of reasoning followed by decision-making or problem-solving. Riley & Hunt (2014) state that computational thinking is a way of thinking and reasoning for computer scientists. National Research Council (2021) Computational thinking skills can be adopted as an approach to solving a problem and analyzing the solution. The computational thinking approach is not limited to computer science but can also be applied to other disciplines through problem-solving.

The computational thinking approach has been integrated into various instruments and learning media. According to Pollock (2019), in mathematics, computational thinking is integrated into some of the students' work related to data analysis, identifying questions that can be answered based on known information on the problems presented. Whereas in physics, mathematics is the main language for translating and simplifying complex concepts.

Research by Segupta et al. (2013) explained that the computational thinking approach can be integrated into the 12-year compulsory education curriculum and into the STEM (Science, Technology, Engineering, and Mathematics) learning curriculum. Basu et al. (2013) developed CTSiM by integrating the computational thinking approach and STEM into a visual science program for high school students.

Based on this description, the researcher intends to discuss the potential for developing computational thinking approach-based physics learning media as a means of increasing students' problem-solving abilities. It is hoped that through this research it will be known how a computational thinking approach can be integrated into physics learning media.

Method

This research method uses a literature review technique. A literature review is a method used to study, identify, interpret and evaluate research on a certain relevant topic. This research used six international scientific articles through scopus.com as the main source and 18 supporting articles through scholar.google.com, which were obtained by entering the keyword "computational thinking approach". Of the many international articles available, several have been selected that have topics relevant to this research, namely the application of the computational thinking approach to learning. An overview of the stage of the literature review can be seen in Figure 1.

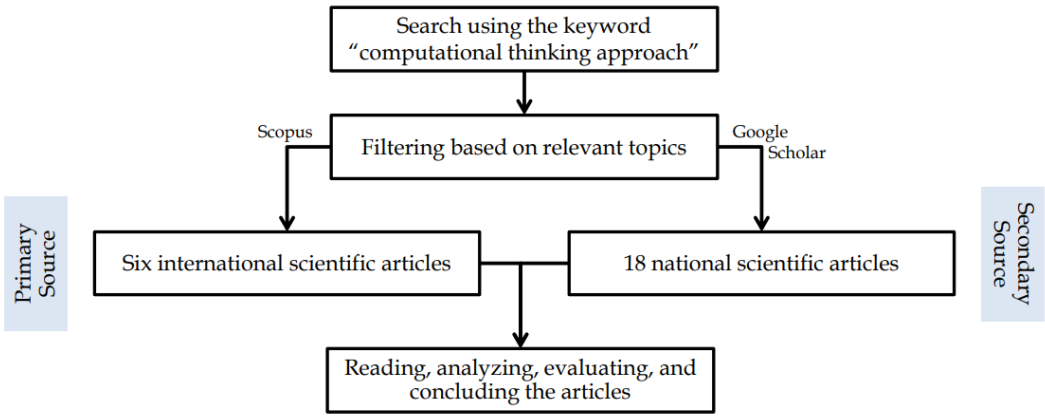

Figure 1 Stages of the literature review

Result and Discussion

Definitions and Steps in the Computational Thinking Approach

Approach in general has a definition as an outline of the direction to act in an effort to achieve the goals set. In line with that, Djalal (2017) explained that the anointing approach is a philosophical framework that is the foundation upon which to achieve the goal. Computational thinking is the ability of scientists to think and reason based on the principles of computer work (Riley & Hunt, 2014). According to Wing (2006), the computational thinking (CT) approach involves the ability to think in problem formulation and finding solutions through abstraction, developing algorithms, and decomposing problems into simple components so that their solutions can be represented as done by information processing agents such as computers, humans, or a combination of the two. It can be concluded that the computational thinking approach is a policy to act in solving problems based on computational principles, namely abstraction, decomposition, pattern recognition, and algorithms.

Zahid (2020) explained that the PISA framework provides an illustration that computational thinking can play a role in the process of solving the problem, both when formulating problems and when doing mathematical reasoning, including by selecting the right

computing tools in the analysis and solving process. the problem. A computational thinking approach is urgently needed considering problem solving skills are needed to solve everyday problems. BBC Bitesize (2020) describes a computational thinking approach that allows us to understand complex problems and develop possible solutions. Then those problems and solutions can be presented in a way that computers, humans, or both understand. It can be concluded that the purpose of the computational thinking approach is to make it easier for humans to analyze solutions to problems, both simple and complex.

Tabel 1. Steps of Computational thinking Approach

The steps	Action
Abstraction	• Focus on important information • Develop a problem-solving plan
Dekomposition	• Analyze the concept of the prob lem • Changing information becomes simpler
Patern Recognition	• Analyze existing problem patterns
Alogarithms	• Solving the problem according to the Steps that have been made at the abstraction stage

(Kidd *et al.*, 2017)

Tabel 2 Comparison of Research in the main article

Author (year)	Method	Conclusion
Wings (2017)	Literature study to explain how computational thinking influences research and education	The computational thinking approach greatly influences research and education. This is because learning patterns of computational thinking facilitate solving problems in research and classroom learning.
Segupta et al., (2012)	Literature study to investigate the relationship between computational thinking approaches and science learning in the K-12 curriculum	The learning environment that uses a computational thinking approach can support physics and biology learning and can improve students' problem-solving abilities.
Basu et al., (2012)	This study used experimental research on 6th-grade elementary and middle school students. Students are given treatment to use learning tools based on scaffolded integrated computational thinking approaches.	The use of scaffolded-based learning tools integrated with a computational thinking approach can create a good science learning environment and has an effective effect on student learning outcomes and problem-solving abilities.
Basu et al., (2013)	This study uses Development Research to develop a science learning environment with a computational thinking approach through simulation and demonstration	Implementation of a computational thinking approach in science learning can be done using CTSiM (Computational Thinking Through Simulation and Modeling). CTSiM is a set of reference frameworks with simulations and demonstrations that guide science learning based on a computational thinking approach.
Gustafsson & Enghag (2014)	This study uses an experimental method with collaborative learning assisted by textbooks that contain problems related to learning topics. Learning is carried out by forming classes into five groups with three members for each group. Learning outcomes were analyzed based on indicators of problem-solving abilities.	collaborative learning assisted by textbooks can improve communication skills among students, cognitive abilities, and problem-solving abilities.
Williams (2018)	This research uses a literature study of 49 articles with four keywords, namely computational thinking, higher education, interventions and effectiveness.	The computational thinking Approach has influenced many things in higher education. Computational thinking intervention occurs quite effectively. This is indicated by the increasing ability of students to investigate a problem, both related to social problems and information technology problems.

Kidd et al. (2017) then formulated the basic steps for implementing a computational thinking approach to solving problems into abstraction, dec omposition, pattern recognition, and algorithms (table 1). Abstraction is the process of focusing attention on important information and ignoring irrelevant details. Decomposition is breaking a complex problem or system into smaller manageable parts. Pattern recognition looks for similarities between and within problems. Algorithms develop step-by-step solutions or rules to

follow to solve problems. These four steps from a robust framework for applying computational thinking approaches, so by integrating these four elements, problem-solving or decision-making with computational thinking approaches become more structured and effective.

Computational Thinking Approach Integration in Media and Learning Instruments

Research conducted by Aggrasari (2021) explains that computational thinking can be a learning model in elementary schools, which includes the stages of formulating problems, managing and analyzing logical data, representing data through abstraction and simulation, finding solutions through algorithmic thinking, and generalizing the solution process for various problems. Based on research presented by and Chorianopoulos (2017), computational thinking integrated with media learning was able to enhance CT skills and student motivation using simulation and video game construction. This potential makes it necessary to develop various learning strategies, tools, and media that are integrated with a computational thinking approach.

The computational thinking approach has been integrated into various instruments and learning media. Research conducted by Ahsan et al. (2021), proved that Student Worksheets with a computational thinking approach based on web apps can be an alternative learning media used during the COVID-19 pandemic. The worksheet design has been adapted to the requirements of a good worksheet. This design has embedded and integrated computational thinking into learning content. It is hoped that this design can be realized as one with learning tools that teachers can use as a solution for distance learning as a result of the 2021 COVID-19 pandemic. Rahmania (2022) developed the student worksheet with a computational thinking approach. The product resulting from the development is declared valid and practically used in improving students' critical thinking skills and self-confidence. Research by Segupta et al. (2013) explained that the Computational thinking approach can be integrated into the 12-year compulsory education curriculum and the STEM (Science, Technology, Engineering, and Mathematics) learning curriculum.

Basu et al. (2012) succeeded ence based on a computational thinking approach for elementary school students. This model is called CTSiM (Computational thinking in Simulation and Modeling). Then, Basu et al. (2013) developed CTSiM by integrating the computational thinking approach and STEM into a visual science program for high school students. Hsu and Chen (2022) found that Computational thinking-based board games can be integrated with the use of speech recognition applications (Siri and Google Assistant) as new media in learning in Artificial Intelligence courses for students. Furthermore, the comparison of developing computational thinking approach-based learning media can be seen in Table 2.

Based on the description above, the computational thinking approach can be integrated into instruments and learning media for various subjects so that it has the potential to also be applied to physics learning media. In addition, it was found that learning with a computational thinking approach is closely related to students' problem-solving abilities.

Conclusion

Based on the results of the research and discussion, it can be concluded that the computational thinking approach has the potential to be integrated into physics learning. This is marked by the many previous studies that were able to integrate it in various learning devices and media. In addition, it was found that learning with a computational thinking approach is closely related to students' problem-solving abilities so that physics learning media based on a computational thinking approach has great potential as a means of increasing students' problem-solving abilities.

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References

Abdani, R., Rokhmat, J., & Rahayu, S. (2018). Pengaruh Pendekatan Berpikir Kausalitik Ber-Scaffolding dengn Pemberian Tugas Pendahuluan Terhadap Kemampuan Pemecahan Masalah Siswa SMA. *Jurnal Pendidikan Fisika dan Teknologi,* 4(2), 213-219. https://doi.org/10.29303/jpft.v4i2.818

Aggrasari, L.A., (2021). Model Pembelajaran Computational thinking Sebagai Inovasi Pembelajaran Sekolah Dasar Pascapandemi Covid-19. *Prosiding Seminar Nasional Sensaseda,* 1, 109-114. https://mathdidactic.stkipbjm.ac.id/index.php/sensaseda/article/view/1553

Ahsan, M. G.K., Cahyono, A.N., & Prabowo, A. (2021). Desain Web-apps-based Student Worksheet dengan Pendekatan Computational thinking pada Pembelajaran Matematika di Masa Pandemi. *PRISMA, Prosiding Seminar Nasional Matematika,* 4, 344-352. https://journal.unnes.ac.id/sju/index.php/prisma/article/view/44971

Basu, S., Dickes, A., Kinnebrew, J.S., Segupta, P., & Biswas, G. (2013). CTSiM: A Computational thinking Environment for Learning Science through Simulation and Modeling. *Conference: In Proceedings of the 5th International Conference on Computer Supported Education,* 369-378. https://pdfs.semanticscholar.org/fcd1/46d8504cb50ed89f99af67d66cedfd158c18.pdf

Basu, S., Kinnebrew, J.S., Dickes, A., Faris, A.V., Sengupta, P., Winger, J., & Biswas, G. (2012). A Science Learning Environment using a Computational thinking approach. *Conference: 20th International Conference on Computers in Education,* 722-729. https://pennstate.pure.elsevier.com/en/publications/a-science-learning-environment-using-a-computational-thinking-app

BBC Bitesize. (2020). Computational thinking - KS3 Computing - BBC Bitesize. Retrieved October 10, 2020, from BBC Bitesize: https://www.bbc.co.uk/bitesize/topics/z7tp34j

Citra, K.A., Nehru., Pujiningsih, F.B., Riantoni, C. (2021). Keterampilan Pemecahan Masalah Siswa Pada Materi Listrik Arus Searah di Masa Pembelajaran Jarak Jauh. *Jurnal Pendidikan Fisika dan Teknologi (JPFT)*. 7(2). 75-79. https://doi.org/10.29303/jpft.v7i2.2663

Djalal, F. (2017). Optimalisasi Pembelajaran Melalui Pendekatan Strategi dan Model Pembelajaran. Sabilarraysad. 2 (1). *Jurnal Dharmawangsa* 31-52. https://jurnal.dharmawangsa.ac.id/index.php/sabilarrasyad/article/view/115

Garneli, V., & Chorianopoulos, K. (2018). Programming video games and simulations in science education: exploring computational thinking through code analysis. Interactive Learning Environments, 26(3), 386-401. https://doi.org/10.1080/10494820.2017.1337036

Gunawan, Gunawan, Harjono, A., & Sutrio, S. (2015). Multimedia Interaktif dalam Pembelajaran Konsep Listrik bagi Calon Guru. *Jurnal Pendidikan Fisika Dan Teknologi*, 1(1), 9. https://doi.org/10.29303/jpft.v1i1.230

Hsu, T.C., Chen, M.S. (2022). The Engagement of Student When Learning to Use a Personal Audio Classifier to Control Robot Cars in a Computational Thinking Board Game. *Research and Practice in Technology Enhanced Learing.* 17 (1). 1-17. http://dx.doi.org/10.1186/s41039-022-00202-1

Ifriliya, H., Hayat, M. S., Roshayanti, F., & Siswanto, J. (2022). Potensi Implementasi Computational Thinking pada Pembelajaran Fisika. *Unnes Physics Education Journal,* 11(3), 1-14. https://doi.org/10.15294/upej.v11i3.59969

Kidd, T., Lonnie R, & Morris, Jr. (2017). *Handbook of Research on Instructional Systems and Educational Technology.* United States of America: IGI Global.

National Research Council. (2010). *Report of a workshop on the scope and nature of computational thinking.* Washington, DC: The National Academies Press

Noviatika, R., Gunawan., & Rokhmat, J. (2019). Pengaruh Model Pembelajaran Berbasis Masalah BErbantuan Mobile Pocket Book Fisika Terhadap Kemampuan Pemecahan Maslaah Peserta Didik. *Jurnal Pendidikan Fisika dan Teknologi.* (5) 2. 240-246. https://doi.org/10.29303/jpft.v5i2.1163

Pollock, L., Mouza, C., Guidry, K. R., & Pusecker, K. (2019). Infusing Computational thinking Across Disciplines. P*roceedings of the 50th ACM Technical Symposium on Computer Science Education - SIGCSE* '19. https://doi.org/10.1145/3287324.3287469

Rahmalia. D. A. D., Anis Z. (2021)Analisis Kemampuan Pemecahan Masalah Fisika Pada Materi Gerak Parabola SMA. *Proceeding od Integrative Science Education Seminar,* 1, 575-580. https://prosiding.iainponorogo.ac.id/index.php/pisces/article/view/337/158

Rahmania, S. (2022). Pengembangan E-LKPD dalam Pembelajaran Matematika dengan Pendekatan Computational thinking Untuk Mengintegrasi Kemampuan Berpikir Kritis dan Rasa Percaya Diri. *APOTEMA : Jurnal Program Studi Pendidikan Matematika.* 8(2). 133-145. https://doi.org/10.31597/ja.v8i2.820

Rahmawati, A.S., & Ika, Y.E. (2020). Perbedaan Keefektifan Model Pembelajaran Kooperatif Tipe STAD (Student Team Achievement Division) dan Jigsaw Terhadap Kemampuan Pemecahan Masalah pada Pembelajaran Fisika. *Jurnal Pendidikan Fisika dan Teknologi (JPFT)*. 6(1). 162-168. https://doi.org/10.29303/jpft.v6i1.1661

Riley, D., & Hunt, K. (2014). *Computational thinking for the Modern Problem Solver*. Boca Raton: CR Press.

Schleicher, A. (2018). PISA 2018 Insights and Interpretations. https://www.oecd.org/pisa/PISA%202018%20Insights%20and%20Interpretations%20FINAL%20PDF.pdf

Selviyana., Y., Halim, A., Syukri, M., & Elisa., 2022. Application of Problem Based Learning (PBL) Model to Improve Problem Solving Skill from Critical Thinking Skill Students on Dynamic Fluid Materials. *Jurnal Penelitian Pendidikan IPA*, 8(2), 521–527. https://doi.org/10.29303/jppipa.v8i2.1329

Sengupta, P., Kinnebrew, J.S., Basu, S., Biswas, G., & Clark, D. (2013). Integrating computational thinking with K-12 science education using agent-based computation: A theoretical framework. *Edc Inf Technol*, 18, 351-380.

https://www.scitepress.org/Papers/2012/39155/39155.pdf

Utami, R.W., & Urwatul Wutsqa, D.U., (2017). Analisis Kemampuan Pemecahan Masalah Matematika dan Self-Efficacy Siswa SMP Negeri di Kabupaten Ciamis. *Jurnal Riset Pendidikan Matematika.* 4(2). 166-175. http://dx.doi.org/10.21831/jrpm.v4i2.14897

Wing, J. M. (2006) Computational thinking. Communications of the ACM, vol. 49, no.3 March 2006, pp. 33–35. https://doi.org/10.1145/1118178.1118215

Zahid, M.Z. (2020). Telaah kerangka kerja PISA 2021: era integrasi computational thinking dalam bidang matematika. *PRISMA, Prosiding Seminar Nasional Matematika 3,* 706-713. Retrieved from https://journal.unnes.ac.id/sju/index.php/prisma/article/view/37991