e-ISSN 3090-5354
Vol.1, No.2, August 2025
© 2025 Journal of Digitalization in Physics Education

Empowering STEAM Education Through Survival Reality Show: A Literature Review of 'University War' to Enhance Problem Solving Skills in Physics Learning

Bilqisth Dwi 'Athiah[1*], Wasis[1], Noval Hulu[2]

[1]State University of Surabaya, Surabaya, Indonesia
[2]Monash University, Selangor, Malaysia

DOI : https://doi.org/10.26740/jdpe.1.2.39008

Sections Info

Article history:
Submitted: February 22, 2025
Final Revised: June 19, 2025
Accepted: June 21, 2025
Published: August 2, 2025

Keywords:
Learning;
Physics;
Problem Solving;
Reality Show;
STEAM.

ABSTRACT

Objective: *This study intends to analyze the enhancement of problem-solving abilities through the survival reality program 'University War' in high school physics learning and to characterize the empowerment of STEAM education.* ***Methods:*** *This study employs a library research approach. Thirty-two journal articles were evaluated to collect secondary data, which was obtained through the evaluation of research journals from various online journal sources.* ***Results:*** *Of the papers that were evaluated, one survival reality show and eighteen essays from 2020 to 2024 addressed the matter in question. The findings and analysis of secondary data, demonstrating how STEAM education is strengthened through the survival reality show 'University War' in physics learning at the high school level, are very suitable for applying to improve problem-solving skills.* ***Novelty:*** *In addition to improving problem-solving skills, STEAM empowerment through the TV program can increase student motivation. The challenges in the program are suitable for students to improve their problem-solving skills and also provide a non-monotonous classroom atmosphere.*

INTRODUCTION

One of the most important abilities that people in the twenty-first century need to possess is the ability to solve problems (Kurniawan et al., 2024, as cited in Monteiro et al., 2020). These abilities are inextricably linked to critical thinking skills, which are a component of the 4Cs (communication, collaboration, critical thinking, problem-solving, creativity, and innovation). The 21st century has witnessed a steady displacement of human employment by robots, computers, and computerized machinery, driven by the rapid growth of technology (Kurniawan et al., 2024). However, on the other hand, humans are still needed to take care of things that are unexpected and unfamiliar to these computerized machines. Based on the phenomenon described, the current education system needs to provide provisions for students regarding skills in dealing with unexpected problems (Galante & Gnesi, 2022). The skills in question are problem-solving. For learners to be ready to face the world of the future, they require more than just mastery of theories, facts, and procedures (OECD, 2014). Learners need to learn concepts that do not occur routinely so that they can think critically and flexibly when presented with tasks in problem-solving, both inside and outside the classroom (Chetri, 2022).

The importance of students having skills and understanding the steps in problem-solving is emphasized through the opinions of several experts, as presented in Krulik & Rudnick. Krulik & Rudnick (Krulik & Rudnick, 1988) listed the following phases as

problem-solving skills: 1) reading and considering; 2) investigating and planning; 3) choosing a course of action; 4) identifying a solution; and 5) reflecting and extending. The process of problem-solving has been presented as a series of steps known as a Heuristic Plan (Krulik & Rudnick, 1988). The problem-solving process will help learners to think systematically in solving problems. Krulik and Rudnick (1988) have provided key teaching principles to improve learners' problem-solving skills. Learners act as genuine problem solvers. Therefore, research to improve problem-solving skills under various conditions needs to be improved.

Recognizing the importance of problem-solving skills in everyday life is not in line with the reality of the modern educational world. Several studies have concluded that students currently possess low problem-solving skills. According to Kinasih et al. (2023), out of a total of 160 students categorized into three research groups (low, medium, and high), 154 students were classified as poor performers, five as medium performers, and one as high performers. Furthermore, in terms of high school students' problem-solving abilities, the evaluation of the e-learning assessment conducted during the COVID-19 era in the Tuban area of East Java remains of medium value (Mufida et al., 2021). 61.8% of pupils in the Pekanbaru region had difficulty with problem-based learning (Azizahwati et al., 2023).

The factor that causes the low physics problem-solving skills of students is the difficulty of solving a problem related to a material that is made different from the problems given during the learning process (Sari & Abdurrahman, 2020), or it can be said that students have difficulty changing the problem into a simpler mathematical form (Anggara & Wandari, 2021). This is based on the observations of researchers, as students in the learning process are not accustomed to thinking openly about every possibility that can occur from a phenomenon (Chou et al., 2022) or problem (Bravo et al., 2022). The habit of students not thinking openly about every possibility that can occur from a phenomenon and the lack of active student involvement in learning (Zhong et al., 2025, as cited in Yang et al., 2022) resulting in students only knowing solving problems for specific conditions and not for all conditions (Suryanto et al., 2021).

As a teacher or prospective teacher, it is essential to provide the best teaching to students (Akben, 2020). One way to achieve this is through STEAM education (Rusilowati et al., 2020), which encourages students to utilize the latest advancements to think creatively and discover solutions to current issues (Rahmawati, 2021). Through the application of new scientific insights, students can recognize the limitations of their thinking and refine their views (Mun, 2022). Learners will also be encouraged to experiment, be independent, and develop effective teamwork (Rusilowati et al., 2020). STEAM learning is well used in learning Physics in the evaluation or assessment process; the instruments made by the teacher should be connected to real life (contextual) (Chung et al., 2020).STEAM learning will be more effective if it is empowered with learning media that students like. This literature review will discuss the empowerment of STEAM learning through reality shows held in Korea.

The enhancement of STEAM-based education through the survival reality program "University War" highlights the various perspectives from which learning physics can be viewed. This approach, which incorporates STEAM education, trains students in logical thinking skills (Rahmawstudents'., 2024), aiming to improve their problem-solving abilities in high school. Survival reality show 'University War' is a TV show aired in South Korea, featuring several groups from renowned universities in Korea competing in the context of intelligence. The intelligence tested is in the field of mathematics, involving high-level memorization wrapped in the form of a game, as well as deductive ability. Deductive ability is closely related to problem-solving skills because deduction itself refers to the ability to conclude (Chatterjee, 2023).

RESEARCH METHOD

Conducted in light of several factors that are precisely defined and characterized (Higgins & Green, 2008). This study employs a library research methodology, which can be understood as a set of tasks associated with data collection techniques in libraries or studies of research objects obtained from different types of literacy information, including encyclopedias, scientific journals, documents, and magazines (Syaodih, 2009).

Article selection procedure :

The search was conducted during early February 2024 on DOAJ and Scopus from Elsevier. The search was limited from 2020 - 2024. The search terms vary, from problem solving skills to STEAM education in Indonesia, Japan, and even South Korea. Then the following criteria are linked to (Fig.1) when applied to the search results:

1. Journal articles or proceedings written in English.
2. The terms 'STEAM Education', 'STEAM' and 'Problem Solving' appear in the title, abstract, and keywords.
3. Presents interventions for high school and junior high school level education.
4. Establishes the conclusion of the impact of STEAM Education on problem solving skills.

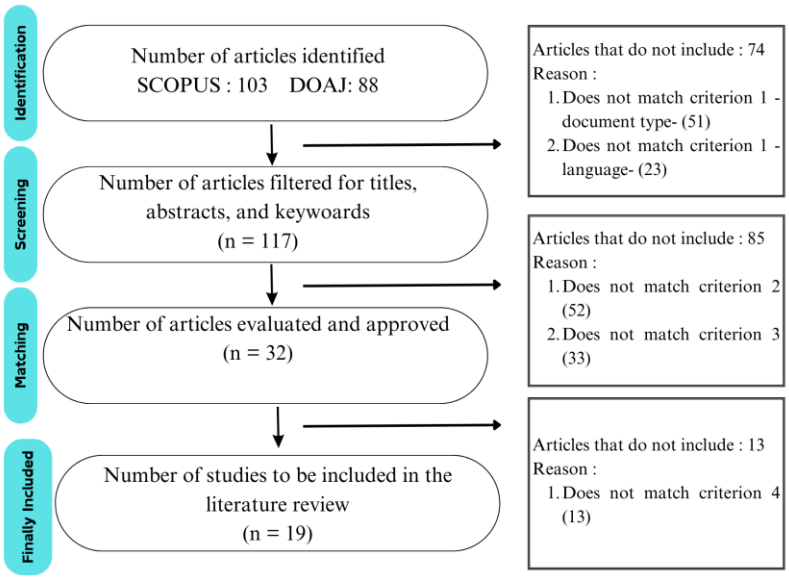

Figure 1. Flowchart of article selection procedure

RESULTS AND DISCUSSION

Results

This article will discuss the empowerment of STEAM Education through the reality show 'University War,' which is used to motivate the physics learning process at the high school level and improve problem-solving skills. Based on a review of several research articles totaling 32 articles. After evaluating the articles and selecting the most suitable ones, 18 articles were finally chosen whose discussions collectively met the criteria. These articles were published between 2020 and 2024. Additionally, a survival reality show was held in Korea in 2024, which became one of the backgrounds for this research. The research results are listed as follows.

Table 1. Table of research results with articles

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
1.	(Survival Reality Show) University War Season 1	Airing in Korea in 2024	Problem Solving Skills	A group of students from Seoul National University (SNU) won the survival reality show. A group of 4 students won after completing the following challenges: Answering 300 short Maths questions, Human chess game, check prime numbers, Formula Archery (making Maths formulas), and many other challenges. When we observed this survival reality show, we realised that the students who participated in this programme were very good at problem solving. The researcher also realised that this ability is not instantly obtained during lectures, but this ability must have been instilled since primary and secondary school.
			PROBLEM SOLVING SKILLS	
2.	Misconceptions of senior high school students in solving high-order thinking skills questions	Anggara, B., & Wandari, W. (2021).	Problem Solving HOTS question	According to this study, a large number of students had theoretical misunderstandings that made it difficult for them to simplify the problem into a simpler mathematical form. Misconceptions about

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
				classification and association impede pupils' capacity to develop their creative abilities. Teachers and other researchers can utilize the discovered misunderstandings as a guide to create mathematics instruction depending on students' aptitudes and potential.
3.	Identification of physics problem-solving skills on senior high school students: An evaluation of elearning during Covid-19 pandemic in Tuban	Mufida, S. N., Sinaga, P., & Samsudin, A. (2021).	Problem-solving skills	The three schools' means were found to be substantially different at 0.002 <0.05 using the Kruskal Wallis test. Students' general proficiency in addressing physics problems pertaining to work and energy is rated as modest. This conclusion indicates that students continue to struggle with relevant descriptions, physics techniques, mathematical processes unique to physics applications, logical progression, and consistent reasoning. As a result, creating instructional resources that can improve students' ability to solve physics problems is essential.
4.	Analysis of student perceptions of problem-solving learning and peer assessment	Nesi, Y. M. D., Kusairi, S., & Nafisah, A. W. L. (2022).	Problem-solving	According to Nesi, Y. M. D., et al. students' problem-solving ability obtained 53.06% results which were included in the sufficient category.
5.	Needs Analysis for Developing Problem Solving-Based E-Module for Projectile Motion to Train High School Students' Conceptual	Azizahwati, A., Purwaningsih, S., Sahal, M., Harlipadensi, H., & Rahmad, M. (2023).	Problem-Solving	As many as 61.8% of students encounter difficulties with issue-based learning, which indicates that they have difficulties understanding and assessing problem solving, according to Azizahwati et al.

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
	Understanding in Pekanbaru			
6.	"Profile of students' Physics Problem Solving Skills and Implementation PBL Model Assisted by 3D Digital Module to Improve Problem Solving Skills"	Kinasih, R. A., Prahani, B. K., Wibowo, F. C., & Costu, B. (2023).	Problem Solving Skills	The data is divided into three categories, according to Kinasih et al.: low (score 0–40), medium (score 41–70), and high (score 71–100). According to the study's findings, 154 pupils were classified as poor performers, five as medium performers, and one as high performer.
			STEAM EDUCATION	
7.	STEAM-deaf learning model assisted by rube goldberg machine for deaf student in junior special needs school	Rusilowati, A., Ulya, E. D., & Sumpono, I. (2020).	STEAM-deaf learning model	Based on deaf students and teachers meeting very excellent and good standards, the study's average percentage was determined. Based on the study's findings, it can be said that using RGM in STEAM-Deaf model learning is a useful and efficient way to help deaf students' cognitive abilities and develop their scientific creativity.
8.	Using an iSTEAM project-based learning model for technology senior high school students: Design, development, and evaluation	Chung, C. C., Huang, S. L., Cheng, Y. M., & Lou, S. J. (2020).	STEAM	Engineers may assist educators in creating and assessing iSTEAM courses and learning activities, as well as offering fresh perspectives and research avenues for STEAM education, by utilizing the iSTEAM teaching paradigm.
9.	The integration of STEAM-project-based learning to train students critical thinking skills in science learning through electrical bell project	Rahmawati, Y., Utomo, E., & Mardiah, A. (2021).	Critical Thinking skills / STEAM-project-based learning	According to the exam results, 40% of the students achieved the master level, and 30% of them were proficient at the critical level. Even after being aware of the transformation's distance, just a little percentage of pupils (3.80%) were unable to appropriately grasp the notion of

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
				transformation..
10.	Using structural equation modelling for understanding relationships influencing the middle school technology teacher's attitudes toward STEAM education in Korea	Kim, Y. H., & Na, S. I. (2022).	STEAM education in Korea	Lastly, it has been demonstrated that instructional efficacy, instructional competence, and acceptance of school educational reform all positively impact attitudes toward STEAM education when instructional resources are collaborated.
11.	Aesthetics and STEAM education: the case of Korean STEAM curricula at the art high school	Mun, K. (2022).	Aesthetics and STEAM education in Korea	Every student envisions their own piece of art, and they meet with professionals in technical education, art, and science on an individual basis to discuss their ideas. Students are able to apply new scientific information and abilities to alter their thoughts and recognize the limitations of their thinking through this learning process.
12.	STEAM Education in Korea: Enhancing Students' Abilities to Solve Real-World Problems	Mun, J., & Kim, S. W. (2022).	Solve Real-World Problems / STEAM in Korea	One of the programs available to high school students is called STEAM RandE, which is funded by the Korea Foundation for the Advancement of Science and Creativity (KOFAC). The program's goal is to improve students' creative problem-solving and peer collaboration skills through STEM/STEAM education. Student-centered research projects, or STEAM RandE, are designed to help students become more adept at solving problems and doing research in the real world.
13.	Integration of	Khoiri, N.,	STEAM and ESD	The intermediate group

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
	STEAM and ESD: Improving the understanding of fluid concepts and creativity	Roshayanti, F., & Widarti, R. (2023).		saw an improvement in student learning results. With an average score of 86.12% in the very excellent category, students' creativity and learning outcomes were successfully enhanced by the usage of learning materials, such as STEAM and ESD subject-based worksheets. There are ramifications for raising student interest in physics instruction from this research. The results of this study may also be used to suggest to curriculum designers that physics professors should employ this model while instructing physics in their classrooms.
14.	STEM and STEAM Affects Computational Thinking Skill: A Systematic Literature Review	Syafe'i, S. S., Widarti, H. R., Dasna, I. W., & Wonorahardjo, S. (2023).	Computational thinking skill / STEM and STEAM	Based on these findings, it can be concluded that STEAM activities are able to have a greater effect than STEM because of the 'Art'.
15.	Developing an Evaluation Rubric for Planning and Assessing SSI-Based STEAM Programs in Science Classrooms	Mang, H. M. A., Chu, H. E., Martin, S. N., & Kim, C. J. (2023).	STEAM	The findings of this study have significance for equipping educators with resources to organize and create STEAM curricula based on SSI.
16.	Effectiveness of STEAM-based blended learning on students' critical and creative thinking skills	Putri, A. S., Prasetyo, Z. K., Purwastuti, L. A., Prodjosantoso, A. K., & Putranta, H. (2023).	Critical and creative thinking skills / STEAM	The findings demonstrated that all indicators with moderate to high categories might benefit from STEAM-based integrated learning in terms of critical and creative thinking abilities. In comparison to the control group, the

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
				experimental group's pupils' critical and creative thinking abilities have improved more. Furthermore, there is a distinction in the learning results between the experimental and control groups. Teachers may find that STEAM-based blended learning offers a viable solution to the issue of students' inadequate critical and creative thinking abilities.
17.	The use of augmented reality to improve students' geometry concept problem-solving skills through the STEAM approach	Nindiasari, H., Pranata, M. F., Sukirwan, S., Sugiman, S., Fathurrohman, M., Ruhimat, A., & Yuhana, Y. (2024).	Problem-solving skills / STEAM	The results of this study show that combining the STEAM method and AR media, students' problem-solving abilities on geometry concepts in the medium category may be successfully improved. The usage of ARM media in conjunction with STEAM instruction, according to the study's findings, can enhance students' ability to solve geometric problems.
18.	Exploring transdisciplinary, technology-assisted, and architectural modelling STEAM practices through a cultural lens	El Bedewy, S., Lavicza, Z., Sabitzer, B., Houghton, T., & Nurhasanah, F. (2024).	STEAM	The analysis of data yielded emergent themes that underscored the potential of STEAM practices to establish links between architecture and culture and history, while also showcasing the diverse range of cultural backgrounds among the participants in all three case studies.
19.	Pengembangan bahan ajar untuk menumbuhkan keterampilan pemecahan masalah menggunakan pendidikan	Keita Murai & Kazuo Kawada (2024)	Keterampilan pemecahan masalah / STEAM	In this project, we created STEAM-ready teaching resources for primary schools that focus on measurement and control technologies. We suggested teaching a peacock to move via

No.	Title	Author & Year	21st Century Skills / Learning Model	Research Result
	STEAM di sekolah dasar (in Japanese)			measurement and control using kinetic art, and we put this lesson plan into practice in a sixth-grade primary school classroom. In order to confirm the value of the course and the learning materials, we polled the students and their homeroom instructors via questionnaire after class.

Discussion

According to the findings of the aforementioned review, there are six publications and one survival reality show that address the value of problem-solving abilities in both real-world situations (Kurniawan et al., 2024, as cited in Dumitru & Halpern, 2023) and the study of physics. Moreover, some studies indicate that students' problem-solving abilities are lacking, particularly while studying physics. The integration of STEAM education to enhance 21st-century skills, including problem-solving, is then explored in 13 additional articles. Consequently, these results align with the goals of this research, which include enhancing problem-solving abilities through the integration of STEAM education (Park & Kwon, 2022). STEAM is one of the programs that helps students develop their problem-solving and research skills in the real world, in addition to enhancing their problem-solving abilities in physics classes (Mun, 2022).

The researcher took several international articles, one of which was an article entitled 'STEAM Education in Korea: Enhancing Students' Abilities to Solve Real-World Problems.' The article provides strong facts that are linear with the success of the survival show 'University War' that airs in South Korea, where there are students who successfully pass problem-solving and math challenges several times using their computational skills in groups (Bers et al., 2022), the audience at least gets the transfer of 21st-century skills just by watching the various mind games in it (Zhong et al., 2025 as cited in Tianthai & Sutamchai, 2022). South Korea is one of the countries with a high culture of collectivity in education (Ying & Tiemann, 2024), allowing the instillation of collaborative problem-solving skills in high school education; even a student is allowed to conduct research, the hope is that students can solve problems that will be experienced in the world of work later (Mun, 2022).

CONCLUSION

Fundamental Finding: The application of STEAM (Science, Technology, Engineering, Art, and Mathematics) in the reality show University War successfully demonstrated participants' collaborative problem-solving skills and cognitive development through

engaging challenges and artistic visualizations. **Implication:** The integration of elements such as math puzzles, spatial mind games, and creative set designs created an immersive learning environment that aligns with interdisciplinary learning goals. This suggests that STEAM-based activities, when presented in dynamic and interactive formats, can significantly enhance critical thinking and student engagement. Learners exposed to such environments tend to develop stronger reasoning and teamwork abilities. However, implementing all five STEAM elements simultaneously in secondary education remains challenging due to curriculum rigidity, limited instructional time, and lack of teacher readiness. Often, educators struggle to create balanced lesson plans that fairly represent each STEAM component. The absence of adequate resources and training further complicates this integration. **Limitation:** Interdisciplinary approaches have great potential to improve both academic outcomes and learner motivation. **Future Sesearch**: Focus on simplifying and adapting STEAM-based challenges such as those from University War to suit classroom contexts, especially in subjects like physics. These adaptations should consider learners' prior knowledge and be aligned with their skill development needs. One promising direction is to embed problem-solving tasks in a game-based or scenario-based format. Such approaches may prevent learning from becoming monotonous and promote sustained engagement. Moreover, the quality of teacher design plays a pivotal role in successful implementation. Certified and well-prepared educators are more likely to deliver meaningful, student-centered STEAM learning. Therefore, professional development in STEAM integration should also be a focus of further studies.

AUTHOR CONTRIBUTIONS

Bilqisth Dwi 'Athiah: Conceptualization, Methodology, Validation and Writing - Original Draft; **Wasis**: Formal Analysis, Resources, Data Curation, Project Administration, and Writing - Original Draft. All authors have read and approved the final version of this manuscript.

DECLARATION OF COMPETING INTEREST

The authors declare no known financial conflicts of interest or personal relationships that could have influenced the work reported in this manuscript.

DECLARATION OF ETHICS

The authors declare that the research and writing of this manuscript adhere to ethical standards of research and publication, in accordance with scientific principles, and are free from plagiarism.

DECLARATION OF ASSISTIVE TECHNOLOGIES IN THE WRITING PROCESS

The authors declare that generative artificial intelligence (Gen AI) and other AI-assisted tools were used judiciously, not excessively, during the research and preparation of this manuscript. Specifically, ChatGPT was used for brainstorming; Grammarly for grammar and style correction. All AI-generated materials have been reviewed to strengthen data accuracy, completeness, and compliance with ethical and scientific standards. The authors are fully responsible for the final content of the manuscript.

REFERENCES

Akben, N. (2020). Effects of the problem-posing approach on students' problem solving skills and metacognitive awareness in science education. *Research in Science Education, 50*(3), 1143-1165. https://doi.org/10.1007/s11165-018-9726-7

Anggara, B., & Wandari, W. (2021). Misconceptions of senior high school students in solving high-order thinking skills questions. *In Journal of Physics: Conference Series, 1918*(4), 042089. https://doi.org/10.1088/1742-6596/1918/4/042089

Azizahwati, A., Purwaningsih, S., Sahal, M., Harlipadensi, H., & Rahmad, M. (2023). Needs analysis for developing problem solving-based e-module for projectile motion to train high school students' conceptual understanding in pekanbaru. *SHS Web of Conferences, 173*, 02005. EDP Sciences. https://doi.org/10.1051/shsconf/202317302005

Bers, M. U., Strawhacker, A., & Sullivan, A. (2022). The state of the field of computational thinking in early childhood education. *OECD Education Working Papers, 274*, Paris https://doi.org/10.1787/3354387a-en

Bowers, J., Anderson, M., & Beckhard, K. (2023). A Mathematics educator walks into a physics class: Identifying math skills in students' physics problem-solving practices. *Journal for STEM Education Research,* 1-27. https://doi.org/10.1007/s41979-023-00105-w

Bravo, B., Pesa, M., & Braunmüller, M. (2022). IDAS: a student-centered teaching methodology to encourage the learning of physics. *Revista Brasileira de Ensino de Física, 44*, 20210326. https://doi.org/10.1590/1806-9126-RBEF-2021-0326

Chatterjee, A. K. (2023). Sherlock Holmes and the adventure of lucid dreaming: The place of oneirogenesis in the science of deduction. *Preternature: Critical and Historical Studies on the Preternatural, 12*(1), 55-83. https://doi.org/10.5325/preternature.12.1.0055

Chen, M. J., She, H. C., & Tsai, P. Y. (2024). The effects of online simulation-based collaborative problem-solving on students' problem-solving, communication and collaboration attitudes. *Education and Information Technologies*, 1-22. https://doi.org/10.1007/s10639-024-12609-y

Chetri, D. R. (2022). The attitude of 10th-grade students in learning physics. *Journal of Research in Social Sciences and Language, 2*(1), 58-70. https://doi.org/10.20375/0000-000f-3242-e

Chou, R. J., Liang, C. P., Huang, L. Y., & She, H. C. (2022). The impacts of online skeuomorphic physics inquiry–based learning with and without simulation on 8th graders' scientific inquiry performance. *Journal of Science Education and Technology, 31*(3), 357-371. https://doi.org/10.1007/s10956-022-09960-5

Chung, C. C., Huang, S. L., Cheng, Y. M., & Lou, S. J. (2020). Using an iSTEAM project-based learning model for technology senior high school students: Design, development, and evaluation. *International Journal of Technology and Design Education*, 1-37. https://doi.org/10.1007/s10798-020-09643-5

Dumitru, D., & Halpern, D. F. (2023). Critical Thinking: Creating job-proof skills for the future of work. Journal of Intelligence, 11(10), 194. https://doi.org/10.3390/jintelligence11100194

El Bedewy, S., Lavicza, Z., Sabitzer, B., Houghton, T., & Nurhasanah, F. (2024). Exploring transdisciplinary, technology-assisted, and architectural modelling STEAM practices through a cultural lens. *European Journal of Science and Mathematics Education, 12*(2), 211-235. https://doi.org/10.30935/scimath/14304

Galante, L., & Gnesi, I. (2022, March). Particle physics role-playing games in introductory physics courses. *In 22nd International Workshop on Neutrinos from Accelerators* (p. 42). https://doi.org/10.22323/1.402.0042

He, J., Ren, S., & Zhang, D. (2024). The relationship between personal-collaborative motivation profiles and students' performance in collaborative problem solving. *Large-scale Assessments in Education, 12*(1), 34. https://doi.org/10.1186/s40536-024-00219-6

Higgins, J.P.T., & Green, S. (2008). Cochrane handbook for systematic reviews of interventions. Wiley. https://doi.org/10.1002/9780470712184

Ishartono, N., Kholid, M. N., Arlinwibowo, J., & Afiyah, A. N. (2024). Integrating STEAM into flip flop model to improve students' understanding on composition of functions during online learning. *Infinity Journal, 13*(1), 45-60. https://doi.org/10.22460/infinity.v13i1.p45-60

Khoiri, N., Roshayanti, F., & Widarti, R. (2023). Integration of STEAM and ESD: improving the understanding of fluid concepts and creativity. *Journal of Education and E-Learning Research, 10*(3), 578-584. https://doi.org/10.20448/jeelr.v10i3.4987

Kim, S. W., & Lee, Y. (2022). Developing students' attitudes toward convergence and creative problem solving through multidisciplinary education in Korea. *Sustainability, 14*(16), 9929. https://doi.org/10.3390/su14169929

Kim, Y. H., & Na, S. I. (2022). Using structural equation modelling for understanding relationships influencing the middle school technology teacher's attitudes toward STEAM education in Korea. *International Journal of Technology and Design Education, 32*(5), 2495-2526. https://doi.org/10.1007/s10798-021-09708-z

Kinasih, R. A., Prahani, B. K., Wibowo, F. C., & Costu, B. (2023). Profile of students' physics problem solving skills and implementation PBL model assisted by 3D digital module to improve problem solving skills. *Jurnal Penelitian & Pengembangan Pendidikan Fisika, 9*(2), 245-256. https://doi.org/10.21009/1.09207

Krulik, S., & Rudnick, J. A. (1988). *Problem Solving: A handbook for elementary school teachers*. Allyn & Bacon/Logwood Division, 160 Gould Street, Needham Heights, MA 02194-2310. https://eric.ed.gov/?id=ED301459

Kurniawan, D., Masitoh, S., Bachri, B. S., Gede Mulawarman, W., & Vebibina, A. (2024). Evaluation of digital project based blended learning model to improve students' critical thinking and problem solving skills. *Journal of Ecohumanism, 3*(8), 1875-1895. https://doi.org/10.62754/joe.v3i8.4847

Mang, H. M. A., Chu, H. E., Martin, S. N., & Kim, C. J. (2023). Developing an evaluation rubric for planning and assessing SSI-based steam programs in science classrooms. *Research in Science Education, 53*(6), 1119-1144. https://doi.org/10.1007/s11165-023-10123-8

Monteiro, S., Sherbino, J., Sibbald, M., & Norman, G. (2020). Critical thinking, biases and dual processing: The enduring myth of generalisable skills. *Medical education, 54*(1), 66-73. https://doi.org/10.1111/medu.13872

Mufida, S. N., Sinaga, P., & Samsudin, A. (2021, November). Identification of physics problem-solving skills on senior high school students: An evaluation of e-learning during Covid-19 pandemic in Tuban. *In Journal of Physics: Conference Series*, *2098*(1), 012017. https://doi.org/10.1088/1742-6596/2098/1/012017

Mun, J., & Kim, S. W. (2022). *Concepts and Practices of STEM Education in Asia* (pp. 199-215). Singapore. https://doi.org/10.1007/978-981-19-2596-2_11

Mun, K. (2022). Aesthetics and STEAM education: the case of Korean STEAM curricula at the art high school. *International Journal of Science Education, 44*(5), 854-872. https://doi.org/10.1080/09500693.2021.2011467

Murai, K., & Kawada, K. (2024). Development of learning materials to foster problem-solving skills using STEAM education in elementary schools. *IEEJ Transactions on Electronics, Information and Systems, 144*(3), 156-161. https://doi.org/10.1541/ieejeiss.144.156

Nesi, Y. M. D., Kusairi, S., & Nafisah, A. W. L. (2022). Analysis of student perceptions of problem-solving learning and peer assessment. *Momentum: Physics Education Journal, 6*(1), 73-85. https://doi.org/10.21067/mpej.v6i1.6005

Nindiasari, H., Pranata, M. F., Sukirwan, S., Sugiman, S., Fathurrohman, M., Ruhimat, A., & Yuhana, Y. (2024). The use of augmented reality to improve students' geometry concept problem-solving skills through the STEAM approach. *Infinity Journal, 13*(1), 119-138. https://doi.org/10.22460/infinity.v13i1.p119-138

Organization for Economic Co-operation and Development (OECD). (2014). *PISA 2012 results: Creative problem solving: Students' skills in tackling real-life problems (Volume V)*. Pisa: OECD Publishing. http://www.oecd.org/pisa/keyfindings/PISA-2012-results-volume-V.pdf

Park, W., & Kwon, H. (2022). Research trends and issues including computational thinking in science education and mathematics education in the republic of korea. *Journal of Baltic Science Education, 21*(5), 875-887. https://doi.org/10.33225/jbse/22.21.875

Putri, A. S., Prasetyo, Z. K., Purwastuti, L. A., Prodjosantoso, A. K., & Putranta, H. (2023). Effectiveness of STEAM-based blended learning on students' critical and creative thinking skills. *Int J Eval & Res Educ ISSN, 2252*(8822), 8822. https://doi.org/10.11591/ijere.v12i1.22506

Rachmawati, O. Q., Latifah, E., Wisodo, H., Ghorbiy, B., & Bunyamin, M. A. H. (2024, October). Analysis of student problem-solving skills on static fluid topics. *In Journal of Physics: Conference Series, 2866*(1), 012104. https://doi.org/10.1088/1742-6596/2866/1/012104

Rahayu, S., Setyosari, P., Hidayat, A., & Kuswandi, D. (2022). The effectiveness of creative problem solving-flipped classroom for enhancing students' creative thinking skills of online physics educational learning. *Jurnal Pendidikan IPA Indonesia, 11*(4), 649-656. https://doi.org/10.15294/jpii.v11i4.39709

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

Rusilowati, A., Ulya, E. D., & Sumpono, I. (2020). STEAM-deaf learning model assisted by rube goldberg machine for deaf student in junior special needs school. *In Journal of Physics: Conference Series, 1567*(4), 042087. https://doi.org/10.1088/1742-6596/1567/4/042087

Sari, A. N., Rosidin, U., & Abdurrahman, A. (2020). Developing an instrument of performance assessment to measure problem-solving skills of senior high school students in physics inquiry-based learning. *Scientiae Educatia: Jurnal Pendidikan Sains, 9*(1), 1-13. http://dx.doi.org/10.24235/sc.educatia.v9i1.5654

Siswanto, J., Harjanta, A. T. J., Suminar, I., & Suyidno, S. (2022, December). Digital learning integrated with local wisdom to improve students' physics problem-

solving skills and digital literacy. *In Journal of Physics: Conference Series, 2392*(1), 012025. https://doi.org/10.1088/1742-6596/2392/1/012025

Sung, J., Lee, J. Y., & Chun, H. Y. (2023). Short-term effects of a classroom-based STEAM program using robotic kits on children in South Korea. *International Journal of STEM education, 10*(1), 26. https://doi.org/10.1186/s40594-023-00417-8

Suryanto, H., Degeng, I. N. S., Djatmika, E. T., & Kuswandi, D. (2021). The effect of creative problem solving with the intervention social skills on the performance of creative tasks. *Creativity Studies, 14*(2), 323-335. https://doi.org/10.3846/cs.2021.12364

Syafe'i, S. S., Widarti, H. R., Dasna, I. W., & Wonorahardjo, S. (2023). STEM and STEAM affects computational thinking skill: A systematic literature review. *Orbital: The Electronic Journal of Chemistry,* 208-216. https://doi.org/10.17807/orbital.v15i4.18323

Syaodih, N. (2009). *Metode penelitian pendidikan*. Bandung.

Thianthai, C., & Sutamchai, K. (2022, May). Skills that matter: Qualitative study focusing on the transfer of training through the experience of Thai vocational students. *In Frontiers in Education, 7*, 897808. https://doi.org/10.3389/feduc.2022.897808

Winarti, Ambaryani, S. E., & Putranta, H. (2022). Improving learners' metacognitive skills with self-regulated learning based problem-solving. *International Journal of Instruction, 15*(2), 139-154. https://doi.org/10.29333/iji.2022.1528a

Yang, D., Chen, P., Wang, H., Wang, K., & Huang, R. (2022). Teachers' autonomy support and student engagement: A systematic literature review of longitudinal studies. *Frontiers in Psychology, 13*, 925955. https://doi.org/10.3389/fpsyg.2022.925955

Ying, Y., & Tiemann, R. (2024). A comparative analysis of collaborative problem-solving skills between german and chinese high school students in chemistry. *Education Sciences*, *14*(11), 1198. https://doi.org/10.3390/educsci14111198

Ying, Y., & Tiemann, R. (2024). Development of an assessment tool for collaborative problem-solving skills in chemistry. *Disciplinary and Interdisciplinary Science Education Research, 6*(1), 25. https://doi.org/10.1186/s43031-024-00116-6

Zhong, Y., Fryer, L. K., Zheng, S., Shum, A., & Chu, S. K. W. (2025). From gaming to reality: effectiveness of skills transfer from competitive sandbox gaming environment to near and far contexts. *International Journal of Educational Technology in Higher Education, 22*(1), 1. https://doi.org/10.1186/s41239-024-00500-2

***Bilqisth Dwi 'Athiah (Corresponding Author)**
Afilliation: Universitas Negeri Surabaya
Address: Jl. Ketintang, Surabaya, Indonesia
Email: bilqisthdwi.21068@mhs.unesa.ac.id

Wasis
Afilliation: Universitas Negeri Surabaya
Address: Jl. Ketintang, Surabaya, Indonesia
Email: wasis@unesa.ac.id

Noval Hulu
Afiliation: Monash University, Malaysia
Address: Jalan Lagoon Selatan, Bandar Sunway, 47500 Subang Jaya, Selangor
Email: novalmaleakhi2@gmail.com