JIPF (JURNAL ILMU PENDIDIKAN FISIKA)
p-ISSN: 2477-5959 | e-ISSN: 2477-8451 *Vol. 9 No. 3, September 2024, Page 395-403*

Trends and Hotspots in International Research on Problem Solving in Physics Education

Fani Mardianti [1*)], Winny Liliawati [2], Parlindungan Sinaga [3], Wandi [4], Amir Karimi [5]
Universitas Pendidikan Indonesia, Indonesia[1,2,3,4], Farhangian university, Iran[5]
[*)]Corresponding E-mail: fani.mardianti1403@upi.edu

Received: February 21st, 2024. Revised: July 15th, 2024. Accepted: August 6th, 2024

Keywords :
International Research; Physics Education; Problem Solving

ABSTRACT
Problem solving in physics education that have not been resolved to date causes obstruction of various interests. To comprehensively analysis the global application trends of problem solving in physics education and identify research points that promise problem solving in physics material based on bibliometrics and visual analysis. Publications related to problem solving in physics education from 2003 to 2023 were retrieved from the Scopus. The nation, institution, publication year, author, journal, average citations per item, H index, title, publication keywords evaluated. The VOS-viewer software was used to evaluate term co-occurrence results in order to anticipate problem-solving hotspots in physics education. There were 421 articles in all. (1) In general, the quantity of problem solving in physics education papers has increased during the last 20 years. The top three countries (USA, Indonesia, and Australia) accounted for 63.22% of all published articles. The United States has the most citation. The largest contributor is Universitas Pendidikan Indonesia. Suhandi, A. is the professor with the most articles published in the topic of problem solving in physics education. (2) The research field is organized into seven clusters: "HOTS studies," "cognitive systems ", "problem solving methods", "application program", "curriculum", "distance education", and "PER related to problem solving skill reconstruction will be published in the future". Matlab and problem solving in physics education employment research methodologies may be future hotspots in the field of problem solving in physics education.

INTRODUCTION

Problem solving is an indispensable skill and plays a central role in our daily lives [1]. From the simplest tasks to the most complex challenges, the ability to navigate and solve problems is a critical need for every individual to possess. Every human being is faced with problems in personal

relationships, professional environments, or societal problems. Our capacity to find effective solutions to every problem not only shapes the quality of our existence but also encourages innovation, fosters resilience, and drives societal progress [2]. In this era of change and uncertainty, problem solving is more important than ever, as it empowers individuals and communities to adapt, thrive and have a positive impact on the world.

Problem-solving skills are a valuable asset in today's ever-evolving world, transcending the boundaries of specific disciplines [3]. One interesting way in which these skills can be cultivated and honed is through the field of education, which includes the field of physics education. Physics, which is often considered a complex and challenging subject, provides fertile ground for the development of problem-solving abilities [4]. In the study of the basic principles that govern the universe, individuals are not only introduced to the wonders of the simple physical world but are also forced to grapple with complex concepts and phenomena. Through the process of learning and mastering physics, students can acquire and perfect problem-solving skills that go beyond the classroom.

In the ever-evolving educational landscape, the study of problem solving and its integration into pedagogical practice has gained great momentum [5]. In this domain, physics education research has emerged as fertile and important ground for exploring the complex relationship between problem-solving skills and learning processes. The convergence of these two fields has generated a wealth of research and insights, highlighting the dynamic interaction between problem solving and physics education. With its wealth of studies, theories, and methodologies, the field of physics education research not only expands our understanding of how students learn physics but also contributes to the broader discourse regarding effective problem-solving education.

More broadly, the world of education continues to undergo transformation, adapting to the evolving needs of students and the changing demands of society [6] [7]. Within this dynamic, it is important to recognize and understand the trends that shape the way we approach problem solving and the development of problem-solving skills, particularly in the context of physics education. In this paper, we will examine trends surrounding problem-solving research in the international context of physics education, exploring the valuable contributions it has made to the field of education and its potential to shape the future of education in problem-solving skills. By examining trends in problem solving and the development of problem solving skills in the field of physics education, we can gain a deeper understanding of how these skills develop, and their implications for the wider field of education, as well as explore their significance and wider implications for education and society overall.

METHOD

Analyze global application trends of problem solving in physics education and identify key points based on bibliometrics and visual analysis. Used the Access Scopus database to retrieve publications related to problem solving in physics education published between 2003 and 2023. Then, extract the following information from each publication: country, institution, year of publication, author, journal, average citations per item, H index , title, and publication keywords. The points identified were publication trends over time, geographic distribution of publications (countries and institutions), the most productive authors in solving physics education problems were examined. Next, create a network map to visualize the relationship between keywords using VOS-viewer.

RESULTS AND DISCUSSIONS

Over the past two decades, the field of Physics Education Research (PER) has experienced a remarkable and consistent increase in emphasis on problem-solving skills in the field of physics education [8] [9] [10]. With an annual growth rate of 9.6%, this surge underscores the growing recognition of the important role that problem solving plays in physics pedagogy. There were 421

articles in all. The dynamic nature of this field is driven by the evolving needs of both educators and students, who are increasingly aware of the importance of equipping themselves with problem-solving competencies that extend beyond the confines of the physics classroom. Therefore, PER has responded to this demand by developing innovative teaching and learning approaches that not only enhance problem-solving proficiency but also encourage a deeper and more nuanced understanding of the basic principles of physics [11].

This increased focus on problem-solving skills in physics education is evidence of the commitment of researchers and educators to providing a comprehensive and practical education to students. This signals recognition of the broader utility of these skills in preparing students for a wide range of careers and life challenges. Over time, the growth in PER related to problem solving is expected to continue, encouraging a more holistic and effective approach to physics education that empowers students to address the world's complex problems and contribute to scientific and technological progress.

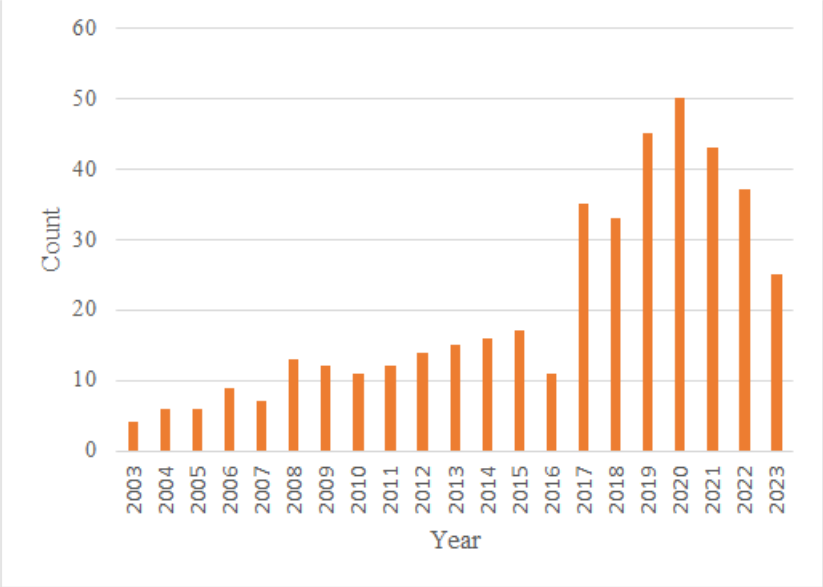

Fig 1. *Annual scientific production*

Fig. 1 highlights a significant and rapid increase in research activities related to problem-solving during the year 2020. This surge can be attributed to the exceptional circumstances that unfolded that year, notably the emergence of the COVID-19 pandemic. As the world grappled with the far-reaching impacts of the virus, the importance of effective problem-solving became more evident than ever [10]. Researchers and educators recognized the urgency of equipping individuals with the skills necessary to address the multifaceted challenges posed by the pandemic. Consequently, this pivotal year marked a watershed moment in problem-solving research, reflecting a collective response to the pressing need for innovative solutions and strategies in a world dramatically altered by the pandemic.

In the 2003-2023 period, the United States, Indonesia and Australia were the three main countries producing problem-solving articles in physics education accounted for 63.22% of all published articles. The United States achieved the top spot with contributions of articles covering a variety of innovative problem-solving methods and strategies in the physics curriculum. The United States is known as a global center for research and development in various scientific disciplines, including physics [12]. Higher education institutions and research centers in the United States contribute substantially to the production of problem-solving articles in physics education, demonstrating their commitment to innovation in teaching and learning. Furthermore, Indonesia showed significant growth in the production of these articles, reflecting its focus on developing teaching methods that encourage understanding of physics concepts through a problem-solving approach. Efforts by

governments and educational institutions to increase problem-solving oriented teaching approaches may be a major factor in this growth [13] [14] [15]. Furthermore, Australia is known for its quality higher education system and focus on a practical approach to learning [16] [17]. The problem-solving articles in physics produced by Australia may reflect their efforts to integrate theoretical concepts with practical applications, ensuring that students can relate theoretical understanding to real-world situations. These three countries together create a diversity of ideas and approaches in the teaching of physics through articles- problem-solving articles, which make a valuable contribution to the development of global physics education.

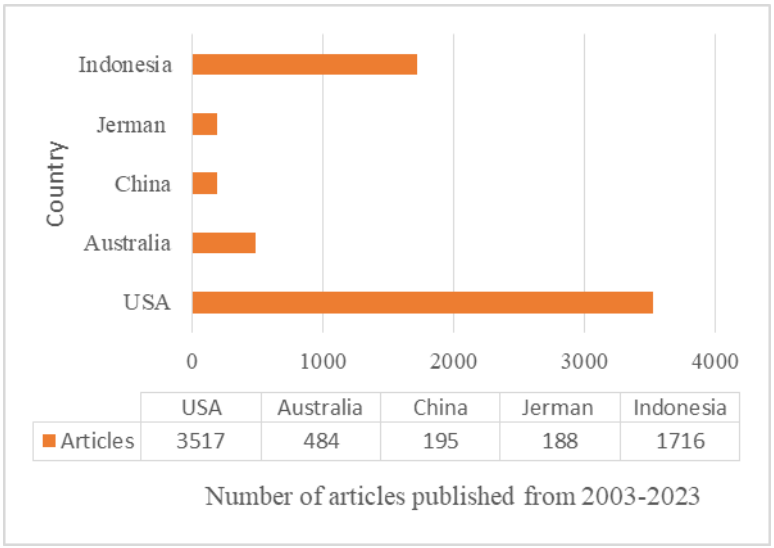

Fig 2. *Distribution production of problem solving articles in physics education in 2003-2023*

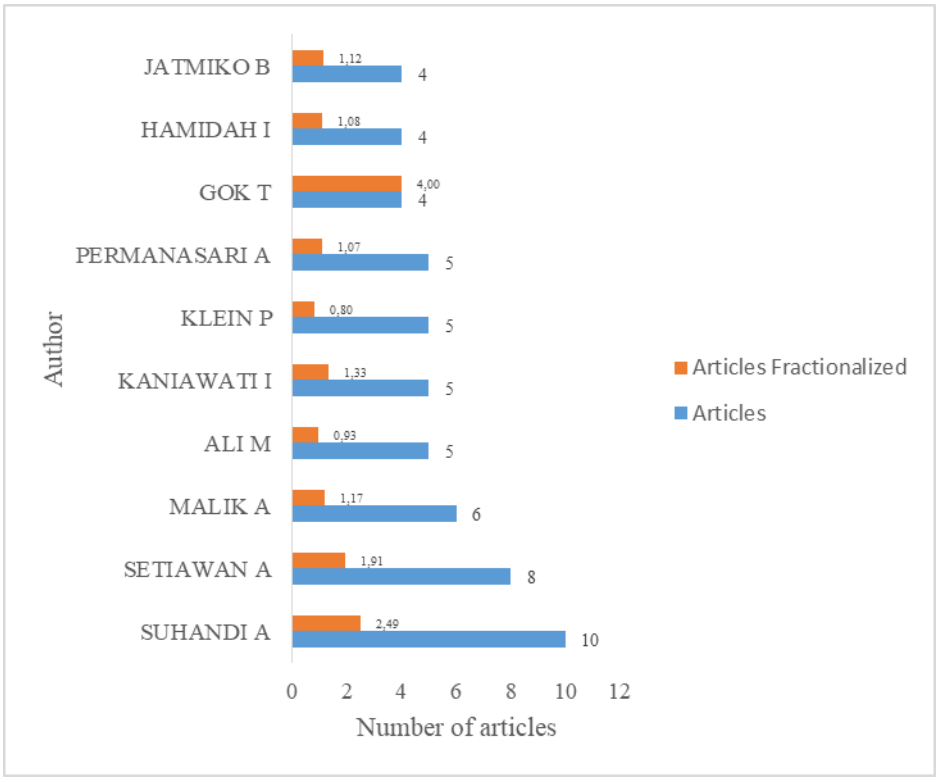

Fig 3. *Most relevant author*

In the field of problem solving in physics education, Professor Suhandi, A. has emerged as a leading figure, standing as the most prolific writer in this field. His impressive contributions include a total of 10 articles, indicating a deep commitment to advancing research and understanding in the area of problem-solving skills in the context of physics education. This extraordinary work not only reflects his dedication but also highlights the importance of his insights and expertise, which will likely be a valuable resource for educators, researchers, and students seeking to improve their problem-solving competencies. Apart from Professor Suhandi, several other authors have made significant contributions to the study of problem solving in physics education. Notably, Giok T, Hamidah I, and Jatmiko B, among others, are among the top 10 authors in this domain, having written four articles each. Their consistent presence among prominent contributors signals a collective commitment to the advancement of problem-solving skills in the field.

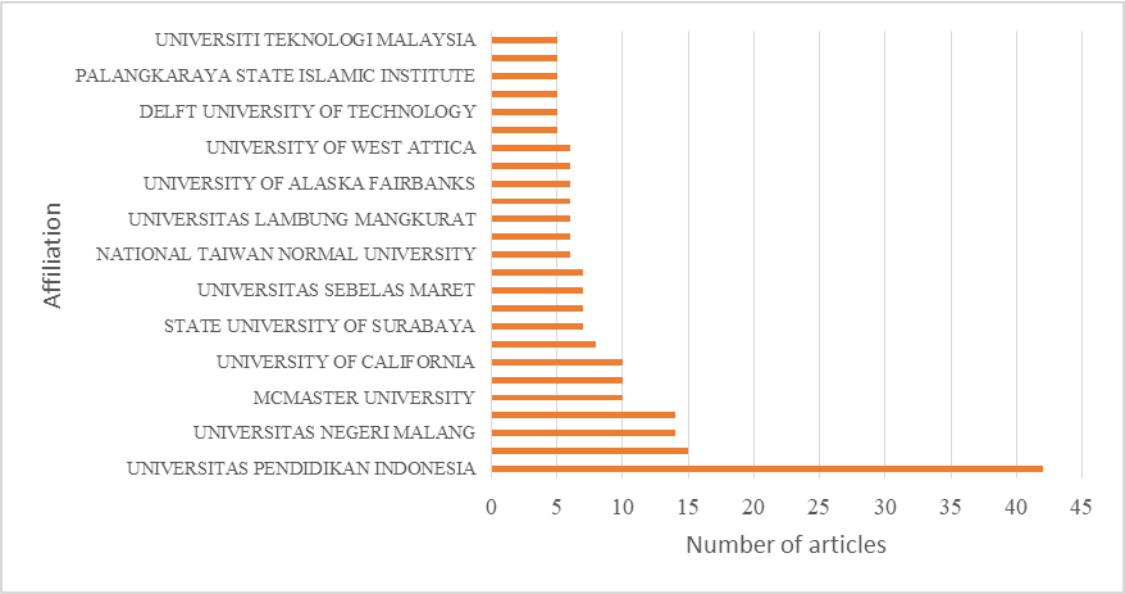

Fig 4. *Most relevant affiliations*

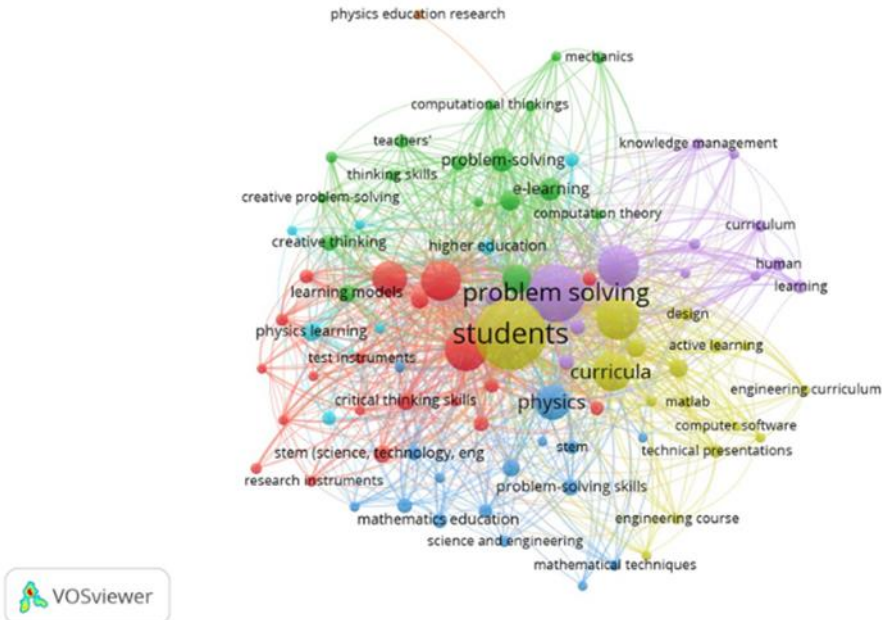

Fig 5. *Mapping co-occurrence by VOS-viewer*

The Universitas Pendidikan Indonesia has emerged as a leading institution around problem solving in physics education, demonstrating extraordinary commitment to this field with a total of 42 articles published. This important work not only underscores the institution's dedication to advancing the understanding of problem-solving skills, but also its important role in shaping the research landscape in this field. Through this extensive contribution, the Universitas Pendidikan Indonesia has played an important role in enriching the knowledge base and developing innovative approaches to problem solving in the context of physics education, thereby having a major impact on the academic and pedagogical aspects in the field of problem solving in physics education.

The organization of research areas into seven distinct groups by the VOS-viewer provides valuable information regarding the solution of diverse problems in physics education research. These clusters represent various aspects of the field, highlighting the various dimensions that researchers are exploring. "HOTS Study" (Higher Order Thinking Skills) signifies an emphasis on developing critical thinking and advanced problem solving skills. “Cognitive systems” explores the cognitive processes underlying effective problem solving, offering a deeper understanding of the role of the human mind in overcoming physics-related challenges. “Problem solving methods” focuses on the strategies and approaches used to address complex physics problems, revealing the most effective methodologies in improving problem solving abilities. “Application programs” most likely address the practical application of problem-solving skills in real-world contexts, going beyond the academic realm. "Curriculum" explores how problem solving is integrated into educational programs, highlighting the importance of a well-designed curriculum in developing these skills. "Distance education" recognizes the role of distance learning in shaping problem-solving education, particularly in the digital era. Finally, the cluster “PER related to reconstruction of problem-solving skills will be published in the future” indicates anticipated future field research efforts, emphasizing the ongoing evolution and relevance of problem-solving skills in physics education.

This grouping of research areas not only offers a comprehensive picture of the multifaceted nature of problem-solving research in physics education but also sheds light on the dynamic and evolving nature of this field. Each cluster represents a different domain of inquiry, contributing to the overall depth and breadth of knowledge and insight surrounding problem solving in the context of physics education. This grouping also implies that researchers are actively engaged in exploring diverse aspects of problem solving, from its theoretical foundations to its practical applications and future evolution, all of which collectively enrich our understanding and inform the development of problem-solving education in the years to come.

The United States stands as the leading country in terms of citations related to problem-solving in physics education, boasting an impressive 328 citations. Following closely behind is Indonesia, with 316 citations to its name. The dominance of the United States in this regard can be attributed to several factors. Firstly, the U.S. has a strong tradition of research and innovation in education, particularly in the field of physics education. Numerous esteemed institutions, dedicated researchers, and well-funded projects contribute to a robust research landscape, fostering the development and dissemination of knowledge. Additionally, the United States hosts a substantial number of international conferences, academic journals, and educational organizations, providing a platform for the global exposure of research findings and subsequent citations. This, in turn, reinforces the country's leading position in the citation count for problem-solving in physics education, underscoring its influential role in shaping the discourse on this vital topic.

Indonesia's substantial number of citations reflects the growing recognition of its contribution to problem-solving research in physics education. The emergence of Indonesian scholars and institutions as prominent voices in this field is a testament to their dedication and the quality of their work. Indonesia's commitment to education and research has gained international recognition, and this is reflected in the citations it has garnered. This dynamic illustrates the global nature of knowledge exchange, where countries like the United States and Indonesia collaborate and inspire one another,

contributing to the enrichment and diversification of research in problem-solving within physics education on a global scale.

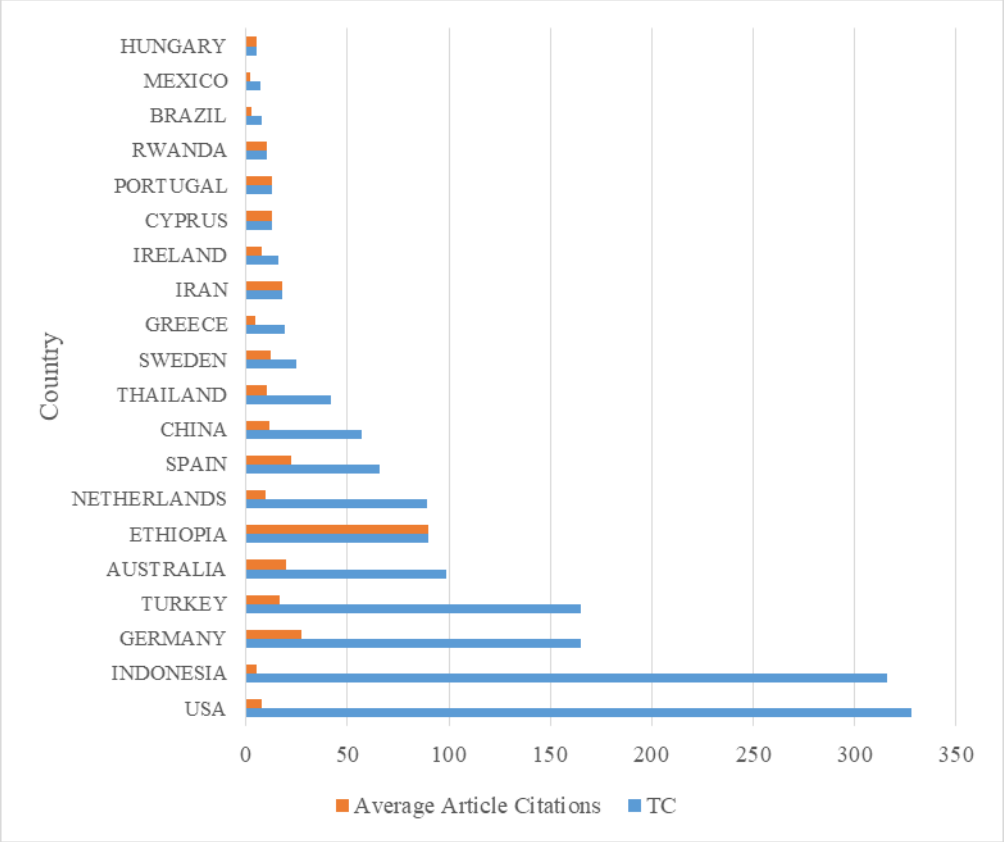

Fig 6. *Most cited countries*

CONCLUSION AND SUGGESTION

A comprehensive analysis of problem-solving in physics education research over the last two decades reveals several noteworthy trends and insights. Firstly, there has been a notable increase in the quantity of research papers dedicated to problem-solving in this field, signifying a growing emphasis on the importance of equipping students with these skills. The contributions of the top three countries, namely Indonesia, the United States, and Australia, amounting to 63.22% of all published articles, underline the global significance of this research, with each nation bringing its unique perspectives and expertise to the table. The United States, with the highest citation count, demonstrates its influential role in shaping the discourse around problem-solving in physics education. Notably, Universitas Pendidikan Indonesia emerges as the largest contributor, highlighting its commitment to advancing knowledge and innovation in the field. Furthermore, Professor Suhandi, A., stands out as the most prolific author in this domain, underlining the impact of individual contributions in shaping the research landscape.

The clustering of the research field into seven distinct clusters provides valuable insight into the multifaceted nature of problem-solving research in physics education, ranging from cognitive systems to distance education. Notably, the anticipation of "PER related to problem solving skill reconstruction will be published in the future" suggests a forward-looking perspective, emphasizing the evolving nature of this field. Looking ahead, the potential future hotspots of "Matlab" and "problem solving in physics education employment research methodologies" hint at the evolving trends in problem-solving research, emphasizing the practical applications and evolving methodologies in the field. These insights collectively offer a valuable roadmap for future research and innovation, ensuring the

continued evolution and relevance of problem-solving in physics education within an ever-changing educational landscape.

ACKNOWLEDGMENTS

Thanks for the Lembaga Pengelola Dana Pendidikan (LPDP) Indonesia for funding this work.

REFERENCES

[1] Hesse, F., Care, E., Buder, J., Sassenberg, K., & Griffin, P. (2015). A framework for teachable collaborative problem solving skills. *Assessment and teaching of 21st century skills: Methods and approach*, 37-56.
[2] Light, P. C. (2010). *Driving social change: How to solve the world's toughest problems*. John Wiley & Sons.
[3] Dunne, G. (2015). Beyond critical thinking to critical being: Criticality in higher education and life. *International journal of educational research*, *71*, 86-99.
[4] Gosling, C. (2004). Challenges facing high school physics students: An annotated synopsis of peer-reviewed literature addressing curriculum relevance and gender. *Journal of Physics Teacher Education Online*, *2*(2), 1-9.
[5] Fenwick, T., Edwards, R., & Sawchuk, P. (2015). *Emerging approaches to educational research: Tracing the socio-material*. Routledge.
[6] López-Alcarria, A., Olivares-Vicente, A., & Poza-Vilches, F. (2019). A systematic review of the use of agile methodologies in education to foster sustainability competencies. *Sustainability*, *11*(10), 2915.
[7] Rof, A., Bikfalvi, A., & Marques, P. (2022). Pandemic-accelerated digital transformation of a born digital higher education institution. *Educational Technology & Society*, *25*(1), 124-141.
[8] Fitzpatrick, S. L., Schumann, K. P., & Hill-Briggs, F. (2013). Problem solving interventions for diabetes self-management and control: a systematic review of the literature. *Diabetes research and clinical practice*, *100*(2), 145-161.
[9] Bao, L., & Koenig, K. (2019). Physics education research for 21st century learning. *Disciplinary and Interdisciplinary Science Education Research*, *1*(1), 2.
[10] Lestari, Syafril, S., Latifah, S., Engkizar, E., Damri, D., Asril, Z., & Yaumas, N. E. (2021, February). Hybrid learning on problem-solving abiities in physics learning: A literature review. In *Journal of Physics: Conference Series* (Vol. 1796, No. 1, p. 012021). IOP Publishing.
[11] Pawlak, A., Irving, P. W., & Caballero, M. D. (2020). Learning assistant approaches to teaching computational physics problems in a problem-based learning course. *Physical Review Physics Education Research*, *16*(1), 010139.
[12] De Greiff, A. (2001). Supporting Theoretical Physics for the Third World Development. The Ford Foundation and the International Centre for Theoretical Physics in Trieste (1966-1973). *American foundations and large-scale research: construction and transfer of knowledge.-(Heuresis.[Sez.] 21.: Sezione di storia della scienza; 1)*, 1000-1026.
[13] Pramana, C., Chamidah, D., Suyatno, S., Renadi, F., & Syaharuddin, S. (2021). Strategies to Improved Education Quality in Indonesia: A Review. *Turkish Online Journal of Qualitative Inquiry*, *12*(3).
[14] Rachmadtullah, R., Yustitia, V., Setiawan, B., Fanny, A. M., Pramulia, P., Susiloningsih, W., ... & Ardhian, T. (2020). The challenge of elementary school teachers to encounter superior generation in the 4.0 industrial revolution: Study literature. *International Journal of Scientific & Technology Research*, *9*(4), 1879-1882.
[15] Indrawati, S. M., & Kuncoro, A. (2021). Improving competitiveness through vocational and higher education: Indonesia's vision for human capital development in 2019–2024. *Bulletin of Indonesian Economic Studies*, *57*(1), 29-59.
[16] Hunt, L., & Chalmers, D. (Eds.). (2021). *University Teaching in Focus: A Learning-centred*

Approach. Routledge.
[17] Pather, N., Blyth, P., Chapman, J. A., Dayal, M. R., Flack, N. A., Fogg, Q. A., ... & Lazarus, M. D. (2020). Forced disruption of anatomy education in Australia and New Zealand: An acute response to the Covid-19 pandemic. *Anatomical sciences education*, *13*(3), 284-300.