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Project-based physics learning model with mindful learning approach: a systematic literature review using PRISMA

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Abstract
Project-based learning models are relevant in physics learning because they can improve high-level thinking skills. However, affective involvement and students' learning awareness are still challenges. This article aims to examine the trends and contributions of using project-based physics learning models integrated with the mindful learning approach. The research method employed is a systematic literature review, utilising the PRISMA approach, of articles published between 2020 and 2025. The study's results suggest that integrating project-based learning and mindful learning has the potential to enhance conceptual understanding, problem-solving skills, and student engagement in the learning process. However, research that directly examines the integration of these two approaches is still limited. The conclusion of this study is the need to develop a physics learning model that combines project and mindfulness elements more systematically to improve learning effectiveness.

Keywords: Mindful Learning, Project-Based Learning, PRISMA, Systematic Literature Review

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I. Introduction

Education plays a crucial role in a country's development, as almost all human activities are closely tied to the education process [1]. Education has a strategic role in developing interpersonal and intrapersonal intelligence in various areas of life to be able to develop existing potential [2]. Developed countries are characterised by superior quality Human Resources (HR) in various aspects, both in terms of spirituality, self-control, personality, intelligence, noble morals, and skills that are relevant to the demands of globalisation [3]. To achieve superior quality human resources, changes and renewal of innovative and adaptive education policies are needed to meet the changing times [4]. Through education, students will gain various experiences in training the abilities and skills they need in community life [5]. In this context, education is an essential aspect that students need to have, especially at the high school level, in order to adapt to increasingly rapid progress [6]. One important aspect in education is the learning process, which must be designed effectively to form a learning culture that supports student development [7].

In the context of physics learning, it must be specifically designed to train and develop students' abilities in understanding scientific concepts [1]. Physics is a challenging topic, and many students dislike it because there are numerous formulas to remember [8]. Several previous studies have found that many problems persist in the ongoing physics learning process, including a tendency to feel bored while learning physics and a lack of interest in physics subjects [9]. Consequently, most students receive physics exam scores below the KKM

standard [10]. According to research [5], there is a lack of interest in learning and poor student learning outcomes for the material being taught. Currently, physics learning primarily focuses on theoretical concepts in class, although this approach is important in helping students develop a deeper understanding of the subject matter. However, sometimes this method results in students feeling bored with monotonous learning and not exploring their ideas [11]. Physics learning still cannot invite students to be actively involved and is not effective in the classroom learning process, because it is still centred on teachers who seem old-fashioned and monotonous [6].

The reality in the field also shows that the current learning process is still unable to provide meaningful learning experiences for students, as most of it is still developed with a teacher-centred approach [12]. Although group-based learning activities are often employed, the teacher's role remains dominant as an information centre, resulting in uneven student learning outcomes [13]. In addition, the lack of full awareness of students about what they are learning and the objectives of the learning also contributes to low motivation, concentration, and achievement of learning outcomes [14]. The learning process often takes place without full awareness, where students are trapped in old, rigid mindsets, use a single perspective, and fail to recognise various alternative ways of understanding knowledge [15]. Therefore, a learning approach is needed that not only emphasises cognitive aspects but is also able to develop students' awareness, attention, and overall involvement during the learning process [13]. In facing these various obstacles, the mindful learning approach is present as a relevant alternative to answer the need for more meaningful and effective learning in improving the quality of student involvement in the learning process [12].

The learning process will take place well, correctly, and accurately, and achieve optimal results if the teacher has a teaching method that can support students in maximising their learning activities [16]. The application of the PJBL model is one option to overcome the problems above [8]. PjBL is a learning model that implements a project, in which students will create a product and are given the freedom to determine what product to make and present [17]. Thus, students not only function as recipients of information but also as creators who develop understanding through real experiences [18]. This model has the following learning steps: 1) Establishing initial questions regarding the project to be created, the teacher facilitates and guides students to be able to complete the project, 2) Designing project completion steps and management, 3) Determining the project completion schedule, 4) The teacher monitors students in the progress of project implementation, 5) Assessing the results of compiling the project results presentation report, 6) Evaluating the results of student projects [19].

PjBL has several advantages that can enhance students' understanding, including the opportunity for students to become "experts" by conducting their own research and projects, which can accustom them to conducting more in-depth investigations [16]. The PjBL model gets better grades than the regular learning model and also allows students to collaborate with others [20]. Project-based learning encourages students to understand real problems and find solutions to those problems rather than just relying on memorising facts and figures given to them by the teacher [10]. In addition, this model also fosters a sense of collaboration and teamwork among students, as well as empathy, as they work together to complete a project [21]. The application of PjBL-based learning is an effective learning model that enhances student engagement, fosters interest in learning, promotes understanding of the material, and encourages collaboration between students and educators [22]. The PjBL model requires students to play an active role in the learning process, which aligns with their perspective [23]. When using project-based learning, students attract more attention, allowing the formation of abstract concepts, which makes the absorption of material easier, and motivation increases. As a result, learning becomes more realistic and meaningful [24].

Although PjBL has proven to be effective, its implementation still faces various limitations [25]. The limitations of PjBL in physics must be addressed, given its relatively long implementation time [26]. According to research by Zhang [27], students often struggle with managing complex project tasks, lack in-depth reflection on the concepts learned, and experience limitations in self-regulation during the learning process. Students who struggle to find sources of information will encounter difficulties in solving their project-related problems [28]. The selection of subject matter also needs to be considered in the development of project learning tools [29]. Students have difficulty understanding physics material, which is characterised by their inability to understand example questions due to low motivation and student indifference during learning activities [30]. Therefore, a strategy is needed that can maximise the effectiveness of PjBL by increasing students' awareness of their learning process [31]. The deep learning approach emphasises learning through critical analysis, linking new information to existing knowledge, and applying it in real contexts [32]. This method highlights the importance of a more detailed understanding of the lesson content and the development

of higher-order thinking skills, such as analysis, synthesis, and evaluation [33]. The primary objective of this approach is to ensure that students not only grasp the core of a concept but also relate it to practical contexts relevant to everyday life [34].

This approach is based on three main elements, namely mindful learning, meaningful learning, and joyful learning. In this study, the main focus is given to mindful learning as an approach that emphasises full awareness in the learning process, so that it can improve understanding of concepts in depth [12]. The mindful learning approach can be a solution to the problem, which is formed by emphasising the transformation of a concept into a new form by linking the ideas it encompasses, its experiences, and learning materials through various activities and a pleasant learning atmosphere [13]. Mindful learning in the context of education can be interpreted as an approach that emphasises full involvement and awareness in every aspect of learning, encouraging full mental presence that improves understanding and appreciation of the material [12]. If we receive information as it is presented, without realising the various ways to understand it, then we accept the information without thinking, and vice versa [14]. This emphasises that mindful learning brings students to an active mental state characterised by the ability to distinguish new things, resulting in students' full presence in the learning process, increasing their awareness of ongoing experiences [32].

By integrating Mindful Learning into PjBL, students are not only actively involved in the project but also more aware of the thinking process they are engaging in, which can significantly improve their conceptual understanding in physics learning [13]. The novelty of this study lies in the Systematic Literature Review (SLR) on the integration of the PjBL model and the Mindful Learning approach in Physics Learning, which has been studied separately to date. This approach has the potential to optimise the effectiveness of project-based learning by increasing students' awareness of understanding concepts in depth. Although many studies have examined the effectiveness of PjBL and Mindful learning separately, studies that systematically analyse the integration of these two models and approaches in physics learning are still very limited [35]. Most studies still discuss both separately, without a comprehensive analysis of how integrating them can overcome challenges in project-based learning, especially in physics subjects [15]. Therefore, this study aims to conduct an SLR based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) to identify current research trends, potential benefits, and challenges in implementing this model. The findings of this study are expected to provide educators and researchers with an understanding of how mindful learning can maximise the effectiveness of PjBL in deepening students' conceptual understanding in student learning.

II. Methods

The approach employed in this study is the Systematic Literature Review (SLR) method, which is implemented using the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines [36]. This SLR is carried out by exploring, analysing, assessing, and interpreting all studies related to the topic [37]. The PRISMA method was introduced in 2009 as one of the best methods available to assist authors in conducting systematic reviews and meta-analyses properly, and also helps authors in reviewing structures such as roadmaps [38]. PRISMA was chosen because it ensures a well-structured and organised systematic review process [39]. PRISMA is also the most frequently used method in articles such as literature reviews. With this approach, the author conducts a review and identifies journals systematically by following orderly and clear steps in each process to ensure comprehensive results [40]. The steps are identification, screening, eligibility, and verification [41].

Identification

The identification stage begins with a systematic search of international and national journals through Google Scholar, Semantic Scholar, and the individual journals themselves, utilising their "search" features. The search technique uses the keywords "PjBL", "PjBL physics", "deep learning", "mindful learning", and "SLR". This comprehensive search is designed to cover all relevant publications [42]. The aim is to collect various documents that discuss PjBL models in physics materials using a mindful learning approach, ensuring a strong dataset for further review. During this initial phase, the search is not limited by document type or publication date to maximise the scope of potential findings. The aim is to create a comprehensive list of materials that can later be refined through more stringent criteria. This step is crucial because it establishes the foundation for the quality and breadth of the literature review, which in turn impacts the overall effectiveness of the synthesis and analysis phases that follow. In systematic literature review research, it is necessary to identify as many previous studies as possible that have been conducted in the field to be studied and that are most relevant

to the research topic area, which is very important for direction and methodology, so systematic filtering is needed [43]. The article data search results strategy is presented in Table 1.

Table 1. Database of article data search strategies

Filter	Description
Year	2020-2025
Subject area	Education, PjBL Model, *Deep Learning*
Special topic	PjBL physics, *Mindful Learning*
Education Level	High school
Language	English
Types of scientific work	Journal
Document type	Open Access
Ranking type	Scopus, Sinta

Screening

The next step, the author carried out the data extraction stage, which was based on the inclusion and exclusion criteria method to make the data more specific with the existing research variables [44]. Screening involved a careful examination of the titles and abstracts of the documents identified in the previous stage. This process was guided by certain criteria: only journal articles, not seminar proceedings, with an exclusive focus on those released in the last six years. This time restriction ensures the relevance of the review to current trends and practices in the field of physics PjBL with the help of a mindful learning approach. The selected documents must also be relevant to the fields of science and education, with a clear emphasis on physics material. Then, restrictions were made again regarding the time of publication, namely only for articles published in the last 6 years, namely in the period 2020-2025. By setting inclusion and exclusion criteria, documents that did not meet these criteria were excluded, thus simplifying the collection to include only the most relevant and recent publications [39]. The specified inclusion and exclusion criteria are outlined in Table 2.

Table 2. Inclusion and Exclusion Criteria

Criteria	Inclusion	Exclusion
Title and Content	Related to PjBL and *Mindful Learning*	Not relevant to the title
Year of publication	2020-2025	Published
Publication type	Only journal, proceedings	Review, editorial
Language	English	Others
Focus of discussion	The Relationship between *PjBL and Mindful Learning*	Others
Participation	High School	Others
Accessibilty	Full text	Others
Journal Indexing	Only scopus and sinta	Others

Eligibility

Once the screening was complete, the remaining documents underwent a detailed eligibility assessment. This step involved a thorough review of the articles to verify their direct relevance to the specific theme of the physics PJBL model with a Mindful Learning approach. This process was conducted manually, ensuring that each document was evaluated based on its substantive contribution to the field and its alignment with the thematic focus of the study. The eligibility criteria were rigorously applied to select articles that specifically addressed the PJBL model in physics learning with a Mindful Learning approach. This focused approach helped refine the literature pool to the most relevant studies for assessing the physics PJBL model, providing a clear path for detailed analysis.

Verification

The inclusion criteria were strictly applied to studies that passed the eligibility review. This final literature analysis consisted exclusively of articles that comprehensively discussed the intervention of the PjBL model in the context of physics education with a mindful learning approach. Each document selected at this stage was considered to have significant insights and implications for the field, which directly addressed the objectives of the review. Documents that met the inclusion criteria were catalogued with detailed information about the

authors, study titles, highlights, and key findings. This structured approach not only facilitated a systematic review of the collected data but also prepared the basis for a cohesive analysis, ensuring that all relevant aspects of PjBL in physics education with a mindful learning approach were comprehensively covered. The selection or screening process of articles for review used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) standard introduced by [45], which can be seen in Figure 1.

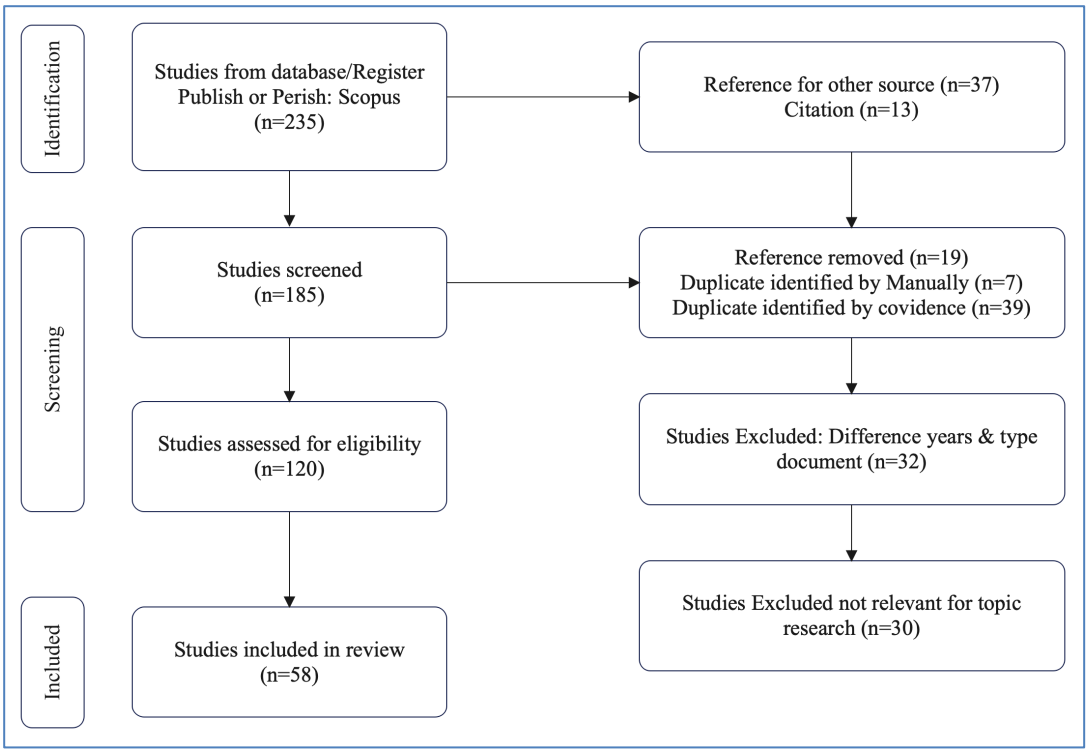

Figure 1. PRISMA Flowchart

Figure 1 shows the research flow using the PRISMA steps, including the stages of identification, screening, eligibility, and verification [46]. Each phase progressively refines the scope of the document, ensuring that only the most relevant studies are included in the final analysis [47]. Based on the PRISMA method that has been carried out, the results of 235 identified scientific journals can be obtained, but there are articles that do not meet the criteria, so only 58 articles are used in this study.

III. Results and discussion

The results of literature screening with the Publish or Perish application on the Google Scholar database from 2020 to 2025 show that there are 58 articles on the PjBL model with a mindful learning approach in physics learning. Table 3. Shows some of the top articles or publications, namely the last five years, obtained from the Publish or Perish results used in this study, as many as 10 articles.

Table 3 presents a summary of the 10 articles analysed in this study, where the articles were selected from a total of 58 relevant articles in the 2020-2025 period that reviewed the project-based physics learning model with a mindful learning approach. The analysis was carried out using a bibliometric approach and thematic synthesis to examine the relationship between the implementation of PjBL, the application of mindful learning, and its contribution in the context of physics learning. Most articles show that the PjBL model is very effective in encouraging active student involvement, building critical thinking skills, and improving conceptual understanding. According to Nurhidayah [48], PjBL not only emphasises cognitive aspects but also develops soft skills that are relevant to the needs of the 21st century. This study is in line with a systematic review by Al-Kamzari [49], which found that PjBL supports the development of students' scientific skills, curiosity, creativity, and critical thinking. However, they highlighted gaps in the full implementation of PjBL core elements, indicating the need to develop a more systematic and consistent framework, especially in the integration of technology and blended learning strategies.

Table 3. Publication Trends in the Last Five Years

No	Title	Author, Year	Journal	Citation	Quartile
1	Project-Based Learning (PjBL) Learning Model in Science Learning: Literature Review	Nurhidayah et al., 2021	Journal of Physics: Conference Series	111	Q4
2	A systematic literature review of project-based learning in secondary school physics: theoretical foundations, design principles, and implementation strategies	Al-Kamzari and Alias, 2025	Humanities & Social Sciences Communications	8	Q1
3	Integrated science, technology, engineering, and mathematics project-based learning for physics learning from neuroscience perspectives	Uden et al., 2023	Frontiers in Psychology	24	Q2
4	Efforts to Improve Student Learning Creativity in Physics Learning Using Project-Based Learning Models	Maison et al., 2024	Journal of Learning and Technology in Physics	55	Q1
5	IF Science AND Making AND Computing: Insights for Project-Based Learning and Primary Science Curriculum Design	Severance et al., 2025	Studies in Science Education	3	Q1
6	Cultivating Mindful Learning in EFL Poetry Class: A Way to Make Creative and Productive Writers	Piscayanti 2021	International Journal of Research in Education	11	Non Q
7	The Interrelationship Among Psychological Capital, Mindful Learning, and English Learning Engagement of University Students in Taiwan	Lin 2020	SAGE Open	51	Q1
8	The Impact of Mindful Learning on Subjective and Psychological Well-Being in Postgraduate Students	Wang et al., 2023	Behavioral Sciences	2	Q1
9	Deep learning in two-dimensional materials: Characterisation, prediction, and design	Meng et al., 2024	Frontiers of Physics	5	Q1
10	Deep Learning Approach Through Meaningful, Mindful, and Joyful Learning: A Library Research	Feriyanto et al., 2024	Electronic Journal of Education, Social Economics and Technology	4	Non Q

The research results of [50] go further by integrating an interdisciplinary approach based on STEM-PjBL, designed using neuroscience principles. This implementation has been proven to be able to build students' self-confidence in learning physics, both in Malaysia and South Korea, especially in classical mechanics material. These results strengthen previous findings that the integration of real and cross-disciplinary contexts in PjBL provides a meaningful and comprehensive learning experience for students. According to Maison [51], they added a dimension of creativity to the effectiveness of PjBL. Students showed that project-based learning not only improved learning outcomes but also encouraged students to think creatively during the learning process. This is in line with the findings of [52], who emphasised the importance of the principles of making and computational thinking in PjBL in elementary schools. This combination not only builds students' agency and STEM identity but also strengthens students' inclusivity and active participation, which are important foundations in 21st-century learning.

On the other hand, strengthening the mindful learning approach also plays an important role in encouraging the effectiveness of holistic learning. According to Piscayanti [53], in the context of poetry

learning during the pandemic, mindful learning can increase students' creativity and productivity. This process involves full awareness, self-reflection, and freedom of thought and expression, which are the basis for developing higher thinking skills. This is reinforced by the findings of [14], which states that mindful learning is the main mediator between psychological capital and student learning engagement, especially in English learning. According to Wang [54], this perspective is further developed by showing a significant relationship between mindful learning, Subjective Well-Being (SWB), and Psychological Well-Being (PWB). This study confirms that mindful learning training contributes to improving the psychological well-being of postgraduate students, as well as being a protector against academic stress. These findings open up great opportunities for the integration of mindful learning in physics learning, especially in building students' resilience and mental toughness in facing complex learning challenges. Furthermore, [54] introduced a deep learning approach in the context of 2D materials research that shows great potential in extracting complex information from big data. Although focused on materials research, this approach is relevant to project-based learning because it emphasises higher-order thinking skills and big data analysis.

In the context of education, [15] combined meaningful learning, mindful learning, and fun learning into a deep learning approach and proved effective in increasing student engagement and understanding of concepts. This integration shows how a holistic framework involving full awareness, intrinsic motivation, and personal connection to learning materials can significantly improve learning outcomes. Overall, the review of the 10 articles forms a complementary understanding between the application of PjBL and the mindful learning approach. Neither is a stand-alone approach, but they can strengthen each other when combined strategically. PjBL provides an active and contextual learning structure, while mindful learning deepens student engagement and awareness in the process. By integrating these two approaches, physics teachers can create meaningful, reflective, and adaptive learning experiences to meet learning needs, especially in physics learning.

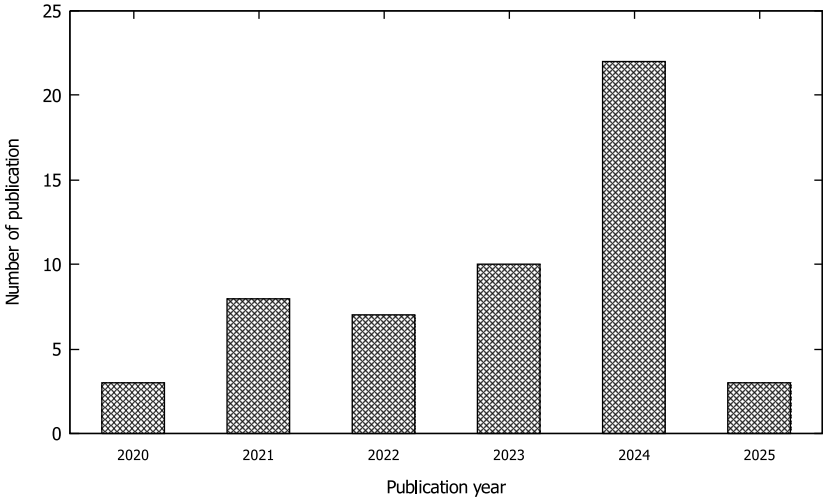

Figure 2. Publication Data of Project-Based Learning Model with a mindful learning approach in physics learning in 2020-2025

Figure 2 shows the development of research publications related to the PjBL model combined with the mindful learning approach in physics learning, both from journals indexed by Scopus and SINTA during the period 2020 to 2025. In 2020, there were three articles discussing PjBL with a mindful learning approach in physics learning. In 2021, there was an increase in the number of articles to 8. However, there was a decrease in 2022 with seven articles, and there was another increase in 2023 with 10 articles. Then in 2024, there was a significant increase of 22 articles, but there was a decrease in 2025 by three articles. In general, the publication trend has increased, especially from 2022 to 2024, which shows that this topic is starting to get more attention from researchers in the field of Physics Education. The visualisation analysis of this publication is mapped into three main parts, namely Network Visualisation, Overlay Visualisation, and Density visualisation, using VOSviewer.

Bibliometric Analysis VOSviewer

VOSviewer is used to analyse bibliometric data by revealing research themes and trends that have emerged over the past five years. The results of research on PjBL with the Mindful Learning approach in Physics

Learning were obtained from keyword analysis of 28 research articles using VOSviewer software. This was done to find research variables on PjBL using the Mindful Learning approach in physics learning. Based on the VOSviewer mapping, several parameters of the relationship between variables related to learning can be found, including design, environment, development, approach, model, implementation, effectiveness, and learning outcomes.

Network Visualization

In bibliometric network visualisation, each item is a keyword or important term in an article, represented by a label and a circle. The size of the label and circle depends on the weight or frequency of the item's appearance in the publication being analysed; the more frequently the item appears, the larger the label and circle [55]. To avoid overlapping between labels, the system automatically hides labels with small weights. The colour of the circle indicates a cluster or group of frequently related topics, while the lines between the circles indicate the strength of the relationship between the items. The results of the network visualisation in this study are shown in Figure 3.

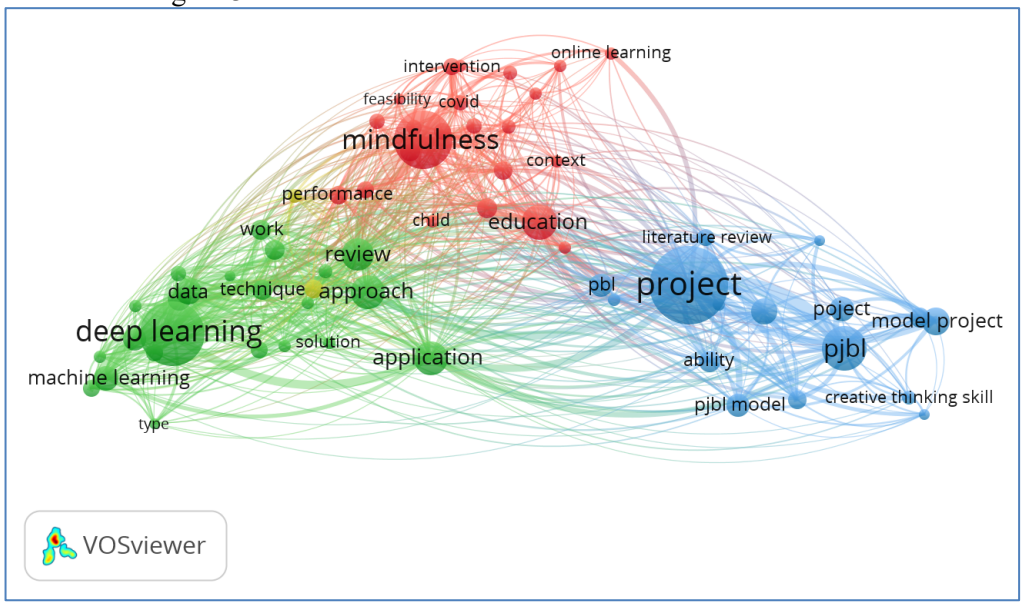

Figure 3. Visualisation of the project-based learning model network with a mindful learning approach in physics learning

Based on the Network Visualisation mapping using the VOSviewer software, several parameters of the relationship between variables can be identified. Figure 3 shows the mapping of the results of the similarity of article keywords, which resulted in 3 groups according to their respective colours, with 28 related keyword terms regarding PjBL integrated with Mindful Learning in physics learning. The three main clusters in this network reflect the thematic focus of the developing research. The first cluster in blue is centred on the terms Project, PjBL, Model Project, Creative Thinking Skill, which indicate a focus on the implementation of PjBL in the context of physics learning. The second cluster in green highlights the terms Deep Learning, Application, Approach, and Machine Learning, which reflect the integration of Deep Learning in learning activities. The third cluster in red connects Mindfulness, Education, and Intervention, indicating that the integration of PjBL and Mindful Learning contributes to physics learning. From the results obtained, the larger the circle on a keyword, the more widely used the keyword is by article authors and the stronger the relationship with other keywords. This shows that these terms are the focus of research on project-based learning models with a mindful learning approach. In addition, the proximity between items or terms indicates a strong conceptual co-existence or relationship between themes. Such as PjBL, Mindful Learning, and Deep Learning, indicating that recent research is beginning to link learning awareness with project-based learning in physics. In general, the closer two journals are to each other, the stronger the relationship. Thus, the results of this network visualisation show that the combination of PjBL and the Mindful Learning approach is a new trend in physics learning, which not only focuses on achieving learning outcomes but also on learning awareness, self-reflection, and the development of students' character and cognition as a whole.

Overlay Visualization

Overlay visualisation has a similar function to network visualisation, but adds a time element or score to show the development trend of terms in the bibliometric map. In the overlay visualisation, there are various colours that determine the score of the item, where, by default, the colours range from blue (lowest score) to green to yellow (highest score), which reflects the dynamics of the topic over a certain period of time [40].

Overlay visualisation serves to map the evolution and development of research over time in an intuitive and informative way. We can see how research trends change and how scientific topics are interrelated. Based on Figure 4, there is a colour transition that shows a shift in research focus from the application of the PjBL Model, which is general in nature, to more specific and current topics, such as the integration of mindfulness, learning awareness, and self-regulation in physics learning. There is a spectrum of dark and light colours; the darker the colour displayed, the more research using the term has been carried out for a long time, and the lighter the colour displayed, the research using the term is still new. Thus, this overlay visualisation provides an illustration that research on the PjBL model in physics has experienced a more contextual and holistic development, with the integration of the mindful learning approach being a relatively new topic, but with the potential for further development.

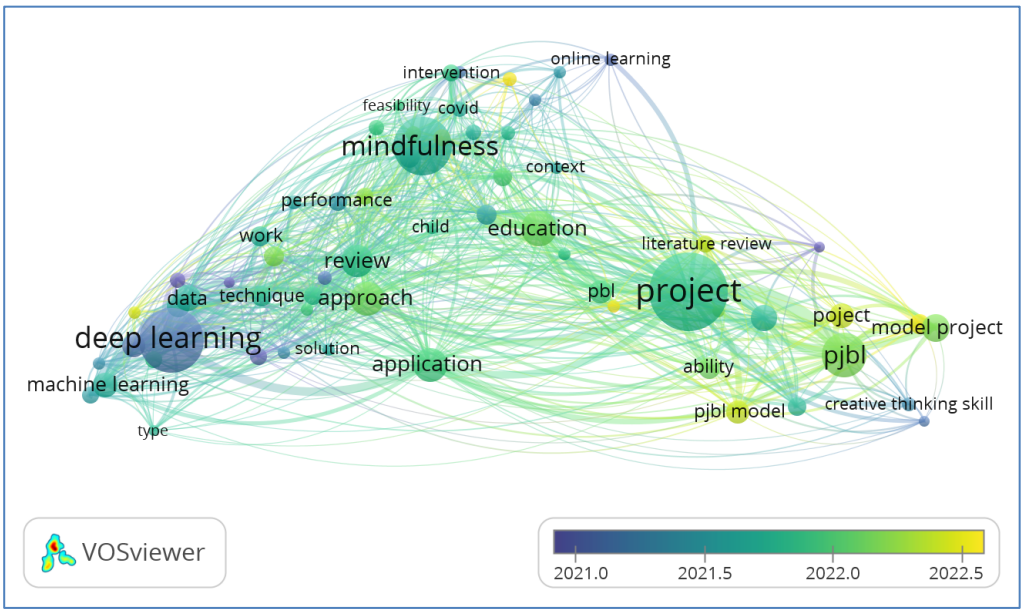

Figure 4. Visualisation of the project-based learning model overlay with the mindful learning approach in physics learning

Density Visualization

Density visualisation in bibliometric analysis allows us to understand the distribution of data density in a research network. This density visualisation illustrates the relative concentration of research activity or the frequency of occurrence of a particular entity in a particular scientific field. This technique is very useful in identifying hotspots or research areas, namely, areas that have high research activity and have great potential for further development. The visualisation of the density results from this study can be seen in Figure 5.

Density visualisation serves to find out how often research using the term is studied. According to [56], terms that have a light and bright background colour indicate that research on the term has been studied frequently, while terms that have a blurred background indicate that the term needs further research. Based on Figure 6, the terms PjBL, Deep Learning, and Mindful Learning have a brighter background, indicating that this theme is a research area that has been explored quite a lot. Meanwhile, the terms creative thinking skill, Approach, Application, and Machine Learning are still in a darker area, indicating that the topic of integrating mindful learning in physics learning is still rarely studied in depth. This indicates a research gap that can be filled by further studies, especially regarding how the mindful learning approach can be implemented effectively in the context of the PjBL model to improve not only the cognitive, but also the affective and metacognitive aspects of students in physics learning. Thus, density visualisation strengthens the finding that

the topic of integration between PjBL and Mindful Learning in Physics is still relatively new and has great potential to be the focus of research.

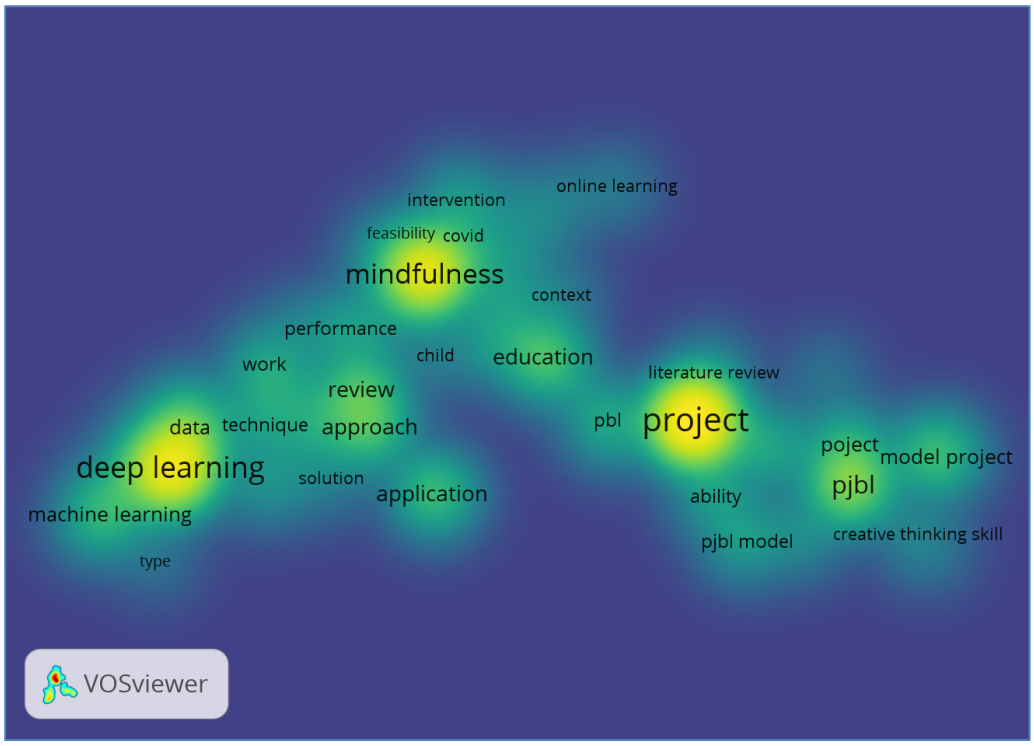

Figure 5. Visualisation of the density of the project-based learning model with the mindful learning approach in physics learning

IV. Conclusions

Based on the results of a systematic review using the PRISMA approach, it was found that the project-based physics learning model has been widely applied in an effort to improve students' 21st-century skills; however, its integration with the mindful learning approach remains relatively minimal and new. Bibliometric analysis suggests that mindful learning plays a crucial role in enhancing students' learning awareness, emotional regulation, and focus during the project-based physics learning process. Thus, the integration between PjBL and the Mindful Learning approach has the potential to be an innovative and holistic learning strategy in physics learning. Therefore, it is recommended that researchers and educators develop learning tools and instructional designs that explicitly combine these models and approaches, and conduct further studies to test their effectiveness in improving physics learning outcomes and character building of students.

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