



Deep Learning as an Instructional Approach to Enhance Students' Creative Thinking and Problem-Solving Skills: A PRISMA-Based Systematic Literature Review

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Article history	Abstract
Submission : 2025-06-18	Creative thinking skills are among the most needed skills in the 21st Century to face the complexities of the future. However, many Indonesian students still lack these skills. The purpose of this research is to explore the role of immersive learning as an instructional approach in improving students' creative thinking skills and problem-solving skills through a literature study. The method used was a systematic literature review using the PRISMA approach, which allows for the selection and analysis of articles from various scientific databases in a transparent, systematic manner. The results showed that the immersive learning approach was consistently positively associated with improvements in students' creative thinking and problem-solving. Immersive learning has been proven effective in encouraging students to analyse, synthesise, and apply knowledge comprehensively, thereby stimulating innovation and creative problem-solving. Implications: These findings are broad and can influence curriculum design, teaching practices, teacher professional development, and further research. Deep learning can be a transformative learning approach to developing the 21st-century skills they need to succeed in an increasingly complex and dynamic world. Further research should expand to include other pedagogical skills, such as the use of technology-integrated learning models.
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1. INTRODUCTION

The 21st Century is a century full of opportunities and challenges. Therefore, a reliable source of power quality is needed for human beings to compete in social life and the nation (Kirana et al., 2021). As time goes by, education has undoubtedly improved, creating challenges we must face for the young generation to continue developing. In the 21st Century, the younger generation needs its own skills; empathy is critical, namely two skills: critical thinking and creative thinking (Zuhriyah, 2022). Another view is that skills are comprehensive in the 21st Century across several main categories. Haka et al. (2022) divide skills into four aspects: method thinking (including creativity and innovation), critical thinking, problem-solving, decision-making, and ability learning. Moreover, how to work like communication and collaboration in a group. In addition, Sumo et al. (2024) recommend that the learning process be directed toward fostering an active, critical, analytical, and creative atmosphere through the development of students' skills.

Ability thinking is very much needed in the 21st Century, an era marked by significant development across various aspects and many challenges that humans must face. Thinking is a skill that can be developed by humans (Sutaphan & Yuenyong, 2023). Students must possess high-level thinking skills; this is very important in learning because it influences the speed and effectiveness of the learning process. In reality, Indonesian students' creative thinking skills remain relatively low (Zaiyar & Rusmar, 2020). The abilities of Indonesian students remain limited to cognitive level 2, even though creative thinking skills require levels 5 and 6 to develop new products, find new solutions, and generate new ideas for problems (Rijal Fiqhi et al., 2023). Ability can be defined as a cognitive process that involves generating diverse ideas, producing original ideas, and evaluating and improving ideas (OECD, 2019; Paz et al., 2025). Thinking creatively is an important skill, especially for connecting concepts and developing problem-solving processes. Thinking creatively is a student process in solving problems uniquely and productively. Hu & Adey (2010) suggest four main characteristics of creative thinking, namely fluency, flexibility, originality, and elaboration. Fluency means the ability to generate many ideas in a short time, flexibility is the ability to view problems from various angles, and originality is the ability to develop ideas in detail (Prayitno et al., 2021).

One of the skills important in the 21st Century is problem-solving. Skills have various definitions. In general, solving problems can be interpreted as the ability to understand situations and recognise complex problems (Hasanah et al., 2025). Ability breakdown problem covers several stages, starting from identify and describe problem, analysis factors the cause, then search and design various alternative solutions, choose the alternative that is considered the most effective, until evaluate what is the solution implemented truly has finish existing problems, mastery skills this is very important for student because can become supplies for face various problems in the future upcoming in a way more effective and more structured (Utami et al., 2023). Students with stronger analytical skills tend to demonstrate greater ability to develop appropriate action plans and make sound decisions. This applies within the context of science education. According to Shofiyah et al. (2024), the breakdown problem is a thinking process that involves the use of Advanced thinking to finish complex issues. While that, the skill breakdown problem alone is an ability to find solutions and generate new ideas (Wati et al., 2025). To improve skills, someone needs to hone their thinking so they can generate more alternative solutions and possibly find new, innovative ideas. According to Nuriyah et al. (2020), problem-solving is one of the skills of the 21st Century, which includes the 4C characteristics: communication, collaboration, critical thinking, and problem-solving. In the learning process, problem-solving ability refers to a student's ability to accept problems as challenges and use knowledge and experience to solve them.

In recent years, rapid technological development has accelerated the creation, distribution, and updating of information, leading to an explosive growth in the volume of community data. To understand information in depth, the data needs to be mined effectively. Answer this challenge: theory suggests that deep learning is designed to automatically and efficiently extract various data features (Zou, 2020). One of the most popular learning approaches today is deep learning. This method eliminates the need for manual feature engineering. It enables data processing at multiple levels of abstraction, enabling deep learning (DL) to automatically discover patterns in complex, high-dimensional data and project them to lower dimensions (Vaishnavi et al., 2021). DL has proven to deliver far higher accuracy across various aspects, such as introduction voice and translation language

nature, compared with other methods. More specifically, deep learning is a branch of artificial intelligence (AI) and machine learning that develops neural network architectures to improve performance in tasks such as object detection and sound recognition. Deep learning is divided into 2 types: (a) deep learning involves learning without supervision, which is used when the target data lacks labels, so the model must find patterns or significant correlations in the observed data without direct guidance (Chusni, 2022). (b) Hybrid deep networks (also called combined deep learning) combine supervised and unsupervised learning to capture more useful patterns (Raup et al., 2022). Deep learning is a type of AI used to diagnose measurable phenomena. According to Jamalpur et al. (2020), although deep learning approaches have proven very effective and successful in handling various application demands, they require high levels of complexity and the ability to absorb large volumes of data, with high accuracy, robustness, and openness. In the system, deep learning is considered equivalent to a professional human. However, to reach its full potential, deep learning must overcome several challenges. Among the challenges is the requirement for a consistent method to manage input data, guarantee transparency from draft to final result, and meet the demands of contemporary computing.

Research conducted by Novitasari et al. (2022) indicates that, based on on-the-ground evidence, creative students are still classified as low. Pre-research results on students in Class VIII of Bandar Lampung State Middle School show that all indicators indicate a creative enter category low. One cause is the approach to learning, which is not yet effective at helping students understand problems and push them to put forward many ideas. In addition, the media did not provide enough support, so students were not sufficiently motivated to study. Students only listened to the teacher's explanation and became accustomed to it, thinking in a convergent way, so they had difficulty thinking creatively and solving problems. An ability to think creatively is a student's ability to develop. If there is no interaction in learning, it will not develop. This is in accordance with opinion from research conducted by Suherman et al., (2021) That, the ability think The creativity possessed by students in Indonesia is still classified as low when compared with ability think creative students in other countries, differences This seen clear in results studies international, primarily through data presentation that compares ability think creative between Indonesian students and students international, one of the proof real can found in the results of the 2018 Program for International Student Assessment (PISA).

Based on a previously disclosed study, the skills of creative high school students are still not fully maximised due to the learning approach and model applied not being sufficiently appropriate, resulting in no significant increase in their skills (Prayitno et al., 2021). Research this in line with Ummah et al. (2021), who found that this skill falls in the low category among students. However, a review by Mulbar et al. (2021) on the influence of model discovery with a scientific approach on students' ability to think creatively shows that the Application of discovery models and scientific approaches is influential and positively affects students. This effectively increases the ability to think creatively and solve problems with a more innovative method. While based on problem-solving research shows. The results of the study by Adeoye & Jimoh (2023) show that skills breakdown is a very crucial problem in pushing innovation and creativity in 21st-century education. This helps students analyse complex problems, develop creative solutions, and implement them effectively, contributing to increased academic performance. Research results by Waruwu et al., (2023) That discussions that took place online proven map increase ability student in think critical and solving problem as well as good management in online discussion for improve results breakdown problem includes planning, implementation, evaluation, action continue, and from results study shown that student capable reach "Good" category on each aspects, In addition, there are theory in study This. Jabali et al. (2024) emphasised that skills breakdown helps individuals create new solutions and develop creative thinking.

According to the description provided above. Research aims to explore the influence of deep learning on the ability to think creatively, using the most effective method for identification and an algorithm to support the development of creativity. In addition, this research will analyse the influence of learning models on the ability to think creatively and solve problems, drawing on various articles on deep learning, problem-solving, and creative thinking, and using the PRISMA framework.

2. METHOD

This research uses the PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method. This method increases transparency and accuracy in reporting, facilitating understanding and enabling replication of studies. PRISMA facilitates the efficient selection process of scientific articles. Furthermore, this method helps detect potential bias and correct research reports, thereby supporting evidence-based decision-making. The information generated through this approach meets high standards of clarity and accuracy (Ariza & Olatunde-Aiye). I researched this. A systematic literature review (SLR) approach is used to explore prominent publications in various fields of academic research (Akmal et al., 2025). This process follows PRISMA Meta-Analysis guidelines with a flow chart consisting of four stages.

Stage 1 is to formulate a relevant research question in accordance with the following PRISMA protocol. A systematic search strategy is applied, including identification, screening, and evaluation of article eligibility, to ensure only high-quality articles are selected. After that, the selected literature was analysed to collect and summarise important data that can answer the study's questions (Yarosan et al., 2024). Finally, a systematic literature review concludes with documentation of appropriate findings based on objective research. All results are studied and then published after the process finishes. Research also uses bibliometric analysis. Bibliometric analysis helps identify, track, and map connections among various fields of science, topics, publications, and streams of knowledge related to this study. Through this process, researchers can understand development research on the Topic-specific, assess scientific contributions from authors and institutions, and identify patterns that emerge in academic publications. Therefore, bibliometric analysis becomes an important tool for capturing dynamics and contributions in the world of research (Chomiak-Orsa et al., 2023). The article data search strategy is shown in Table 1.

Table 1. Strategy database article data search

Filter	Description
Year	2020-2025
Subject area	Deep learning
Topics special	Problem-solving and creative thinking skills
Levels education	All level
Language	English/Indonesia
Work scientific	Journal
Type Documents	Open Access
Type of ranking	Scopus, Sinta

This Publication covers several research trends over the past five years on deep learning, problem-solving, and creative thinking skills in biology education. In the past five years, publications on deep learning, problem-solving, and creative thinking skills have increased significantly. This is due to rapid technological developments and the need for human development skills that machines, such as creativity and critical thinking, cannot easily replace. The main reason for this continued growth is the need for synergy between technological advancements and strengthening human capacity to compete and collaborate effectively in an increasingly complex and dynamic global world. The inclusion and exclusion criteria are shown in Table 2.

Table 2. Inclusion and exclusion criteria

Criteria	Inclusion	Exclusion
Title and content	Relate with Deep learning/Problem solving/and Creative thinking skills	Not relevant to the title
Publication Year	From 2020-2025	Published
Type publication	Only journal, proceedings	Review, editorial
Language	English	Others
Focus discussion	Relate with Deep learning/problem solving /Creative thinking systems	Others
Participation	College, high school /junior high school/elementary school	Others
accessibility	Full text	Others
journal indexing	Only scopus and sinta	Others

Researchers search literature from various sources, including databases, and record the number of articles found. Duplicate articles are then deleted, and the remaining article is selected based on the inclusion and exclusion criteria determined. Next, the journals that are deleted, along with the reason for deletion, also include documentation. Researchers read the abstracts and content of articles to evaluate eligibility and take notes on those that meet the criteria for further review. Relevant articles with requirements and criteria. Then, after entering the analysis, with several articles included and the reasons for his election noted in detail, a list of selected articles was organised into a PRISMA flow diagram, so that every process stage could be monitored more thoroughly and data presented transparently. The article filtering process using the PRISMA method is shown in Figure 1.

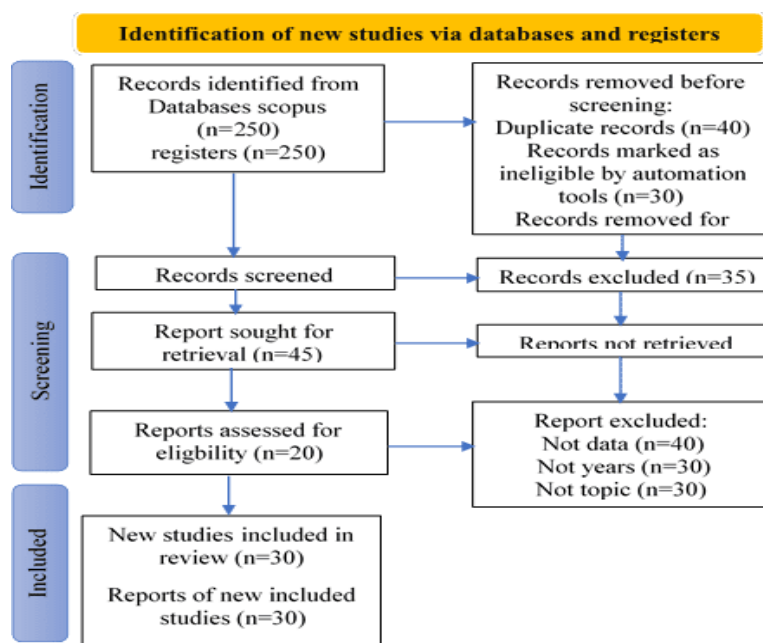


Figure 1. PRISMA Flow Diagram

In this research, data acquisition begins with identifying relevant literature using the keywords "deep learning, problem solving, and creative thinking skills" through searches across various journal databases, Scopus, Publish or Perish, and other sources. At this stage, all of these notes have been recorded in full before filtering. Next, filtering is performed based on the title and abstract to eliminate literature that does not meet the inclusion and exclusion criteria. The reason for the exception for each article is also documented transparently: a database of 250 is then filtered based on criteria, resulting in 30 databases.

3. RESULTS AND DISCUSSION

Several learning models can support the Application of deep learning. Namely, online deep learning involves students holistically and provides adaptive interventions to enhance the quality of the learning experience. (ELOF) Based on deep learning that identifies involved students based on behaviour, emotional expression, and academic achievement (Saleem & Aslam, 2025). Then, a deep learning ensemble bagging approach automatically detects students' engagement during online learning. By merging indicators such as facial expressions, student behaviour (including eye and head movements), and interaction data from the learning platform, the trained deep learning model, using a multi-modal dataset, successfully classifies student involvement with high accuracy. This shows a potentially large-scale ensemble bagging approach to help teachers and to adapt online learning strategies to improve the effectiveness of the learning process for students (Santoni et al., 2024). Research trends in problem-solving, creative thinking, and deep learning are shown in Figure 1.

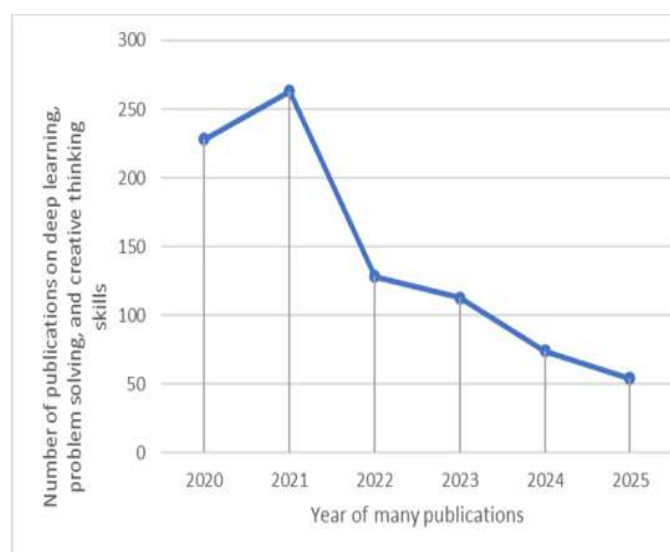


Figure 2. Publication trends for deep learning, problem-solving, and creative thinking skills Five years (2020-2025)

Deep learning, problem solving and creative thinking publication trends show increase in 2020 to 2021, this This can be caused development technology in the year that and the existence challenge new faced so that in the year that trend study happen an increase in 2021 is likely caused by the presence of policy new, stimulus, or recovery economy post-pandemic so that push number from 228 to 263, but after that happen decline sharp start 2022 to 2025 can explained as effect from the end factor the driver, while emergence challenge new like change regulation or structural problems, decline after surge usually to signify factor booster only nature while and numbers will come back down moment factor the lost. The articles analysed for this research are from 2020 to 2025, as shown in Table 3..

Table 3. Articles analysed with the number of citations and Scopus indexing from Q1 to Q3

NO	Title	Author, year	Journal Name	Citation	Quartile
1	The Application of Deep Learning in Image Processing is Studied Based on the Real Neural Network Model	(Xu, 2021)	Journal of Physics: Conference Series	14	Q2
2	The Effect of Guided Inquiry-based Learning with Creative Thinking Ability towards Students' Scientific Process Skill in Analytical Chemistry Courses	(Juniar et al., 2021)	Journal of Physics: Conference Series	5	Q2
3	The development of an environmental change textbook based	(Nuriyah et al., 2020)	Journal of Physics:	4	Q2

NO	Title	Author, year	Journal Name	Citation	Quartile
	on STEM-CP to improve problem-solving skills in high school biology learning		Conference Series		
4	The effect of the problem-based learning model on students' cognitive achievement on high and low students' problem-solving abilities	(Suciati et al., 2020)	Journal of Physics: Conference Series	6	Q2
5	STEM-E: Fostering mathematical creative thinking ability in the 21st Century	(Suherman et al., 2021)	Journal of Physics: Conference Series	11	Q2
6	A survey of deep learning-driven architecture for predictive maintenance	(Li et al., 2024)	Engineering Applications of Artificial Intelligence	23	Q1
7	The development of early childhood students' creative thinking problem-solving abilities through STEM Education learning activities	(Sangngam, 2021)	Journal of Physics: Conference Series	17	Q2
8	An Ophthalmology Study on Eye Glaucoma and Retina Applied in AI and Deep Learning Techniques	Vaishnavi et al., 2021	National Journal of Electrical Engineering and Information Technology	3	Q2
9	Effect of problem-based learning of students' problem-solving ability to learn physics	Gumisirizah et al., 2024	Journal of Physics: Conference Series	15	Q2
10	The effects of meta-creative pedagogy on elementary school students' creative thinking	Paz et al., 2025	Metacognition and Learning	3	Q1

The study of deep learning continues to experience rapid development, as evidenced by the significant increase in publications in leading international journals, which play an important role in disseminating research results. Presently, various articles discuss various aspects of deep learning. Some of the most frequently cited publications show that this study has a significant impact on academics. In addition, sources are prominently identified in studies. This also highlights a trend of improving international collaboration, as well as a shift towards open access, which is increasingly making it easier to distribute knowledge. Deep learning research is more widely applied in the Health and processing sectors, such as machine learning and technology research by Xu (2021). The application of deep learning with neural network models can effectively improve image processing and is rated higher by professionals. Research by Singh & Talwekar (2022) states that deep learning can achieve significant progress in sleep detection by analysing the ECG signal channel in the realm of health. In addition, deep learning (Li et al., 2024) is used in the industrial sector; namely, data-driven deep learning methods are used to monitor degradation and predict the failure of components or assets, intended for an unannounced election and extension product. The search for published articles using the tools is shown in Table 4.

Table 4. Acquisition publication based on a database

Journal name	The amount of Publication
Publish or perish	100
IOP (Journal of Physics Conference Series)	> 60
Sinta	20
Engineering Applications of Artificial Intelligence	5
Metacognition and Learning	5
IEEE	5

Comparison of the Application of learning models for problem solving and creative thinking skills

A learning model based on inquiry-directed, capable learning influences students' ability to think creatively. This is because the model, in a way, invites students to engage in activities based on scientific thinking, thereby pushing the improvement of creativity in solving various problems (Junior et al., 2021). Research results by Novitasari et al. (2022) disclose that the STEM learning model significantly influences the skills of creative students. In addition, research by Suherman et al. (2021) shows that the implementation of the STEM-E learning model can, in a way, be significant for increasing the ability to think creatively in students compared to learning collaboratively with an approach that breaks down problems, which has been proven to be influential in developing creative thinking skills (Zuhriyah, 2022). Research by Paz et al. (2025b) shows that the meta-creative pedagogy approach is practical in fostering creative thinking. This can be seen in the research: creative thinking, especially in fluency and originality, is higher in the class that applies this approach.

A study conducted by Suciati et al. (2020) shows that the Application of learning models based on PBL issues is very influential on students' cognitive abilities, which are related to their ability to solve problems. This is evident in their research results, which show that classes implementing PBL have significantly higher cognitive achievement than conventional classes. The problem based learning model has connection positive and significant to improvement students' problem solving abilities learning, through approach collaborative and student-centered PBL facilitates development skills think critical, creative, and essential analysis in solve problem (Gumisirizah et al., 2024) Research results (Sangnam, 2021) Show The Application of the STEM learning model encourages student For increase ability 21st Century, viewed from results study where students have follow learning with STEM application can increase ability think creative model learning STEM-CP based shows influence significant to improvement ability breakdown problem students, proven from post-test results in class an experiment that shows results more tall from class control (Nuriyah et al., 2020).

This study utilises bibliometric analysis with the support device SoftVOSViewer for precise visual mapping of trends in research and development Topics in the literature. In the discussion of the Literature review results, VOSviewer is used for trend mapping across various fields, allowing researchers to observe the evolution of evaluation topics over time. In addition, VOSviewer can visualise networks of relationships among keywords, and the institutions identified in this bibliometric analysis can be utilised to support decision-making in development policy research, determine the sources of power, and improve the quality of studies by referring to relevant and recent studies. The VOSviewer search results for the keywords Deep learning, problem solving, and creative thinking are visualised in Figure 3.

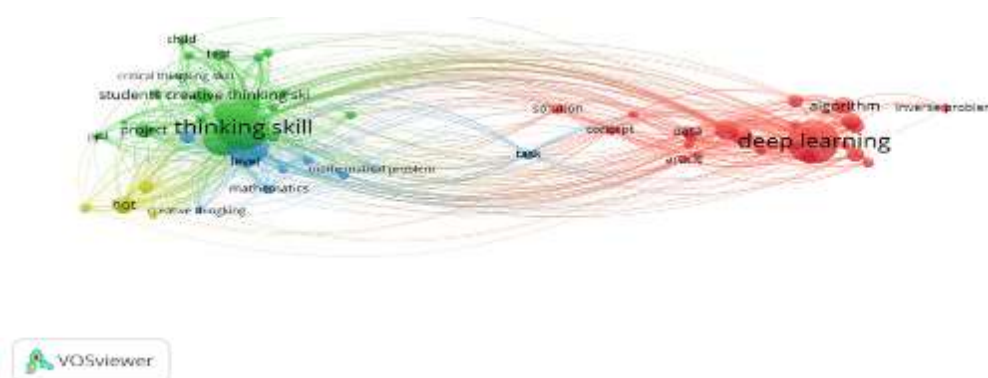


Figure 4. Network Visualisation

Virtualisation keyword network : learning deep (deep learning), solving problems, and thinking creatively. Use VOSviewer to map keywords as nodes, with node size indicating frequency of emergence. At the same time, the connecting lines (edges) depict the simultaneous emergence of keywords. Colours in visualisation grouping of related keywords, related in theme or same topic; the bigger the circle, the more frequently keywords emerge and the more central their role in research (Solihin et al., 2021). This is in line with Putri et al. (2021), where the visualisation in VOSviewer shows connections between elements important in publication data, for example, keywords, authors,

or the country of origin of the writer. Every element is presented as a node (point), while the connection or relatedness between elements is depicted as a connecting line (link). The size of the node reflects the frequency of element emergence in the data, while the colour shows clusters shaped by frequent associations. Import bibliographic data from a scientific database into VOSviewer, then map the network interactively to help identify relatedness among learning deep, solving problems, and thinking creatively, while also displaying the main trends or patterns in the field, making it easier for researchers to identify related research. According to [Dhina et al., \(2021\)](#) in his research visualisation VOSviewer function (1) mapping relatedness between Topic and author in the field of performance, assessment and educational computing (2) identifying trends, major clusters, and current research areas develop or those that are still explored (3) become base for researcher next for determine direction research and strengthen runway study in the field related. Search results for the keywords deep learning, problem solving, and creative thinking with visualisation overlay are shown in Figure 4.

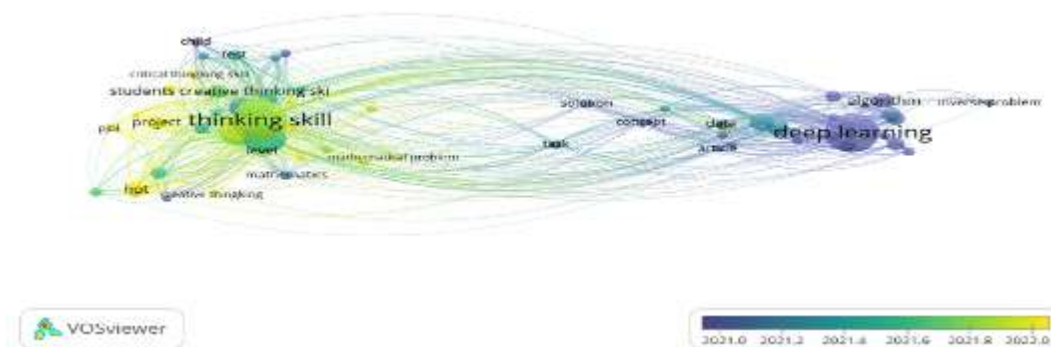


Figure 3. Network Visualisation

Overlay visualisation from VOSviewer This show map keyword network with the color that represents average year of emergence term in Publication, where the keywords such as "deep learning" which is dominated color blue to signify topic this already lots discussed since beginning period analysis around 2021, while the keywords such as "thinking skill". "creative thought", colored green until yellow indicating improvement attention and trends in more publications new approaching 2022, virtualisation it also features connection close between learning deep, solving problems, and skills ability think creative, so that make it easier remove development research and current topics become focus study in field said. According to [Wati et al. \(2021\)](#), colour on the overlay indicates the frequency of terms or topics in the study, with yellow indicating terms that appeared frequently in the latest years, and green and blue indicating topics that appeared more frequently in the previous years. With matters such as these, researchers can easily identify trends, current Topic development, and topics that have been seldom studied. For example, areas with high colour saturation show trending topics that are warm and abundant, which have recently been investigated. On the other hand, the dark-coloured area indicates topics that have been studied longer and may no longer be the focus of recent research ([Megawati et al., 2023](#)). The search results for the keywords deep learning, problem solving, and creative thinking, along with the density relationship between them, are shown in Figure 5.

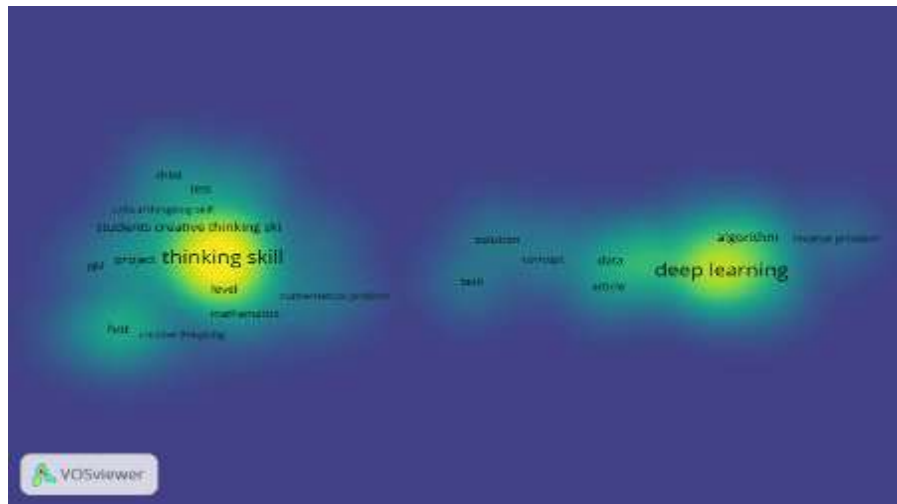


Figure 5. Density Visualisation

The last image, namely, Density Visualisation, is one of VOSviewer's features, which displays areas of high concentration for keywords or frequently used terms in the literature analysed (Triwahyuningtyas et al., 2021). Density visualisation shows density with emergence and relationship between the keywords in the image, where the colored areas are yellow bright on “thinking skills” and “deep learning” signifies both keywords the most frequent become center discussion main, while the other keywords in the image be around center density said, shows existence relatedness and relatedness with study density from color yellow bright, virtualisation This make it easier identify the most influential keywords as well as the most actively discussed research area in the field study related. Colour on density (yellow or red) indicates areas with a high density term (i.e., many studies or publications that discuss the Topic), and the colour is darker (green or blue) indicates areas with a lower density term (Effendi et al., 2021). Benefits of this density visualisation among others, (1) identifying center research, bright area show Topic or the term that becomes center attention and often researched (2) found research gaps, dark areas to signify the Topic is still seldom researched, so that Can become opportunity study next (3) makes it easier data interpretation, researcher can with fast see distribution and density in the field specific without must read all raw data (Jayadinata et al., 2021).

4. CONCLUSION

Based on the discussion of the research results above, in-depth learning plays an important role in improving students' creative and problem-solving skills. Methods that emphasise comprehensively understanding a draft, building connections between ideas, and actively encourage exploration. This is significantly related to improving students' idea discovery, adaptability, and originality in creative thinking, which helps them create innovative solutions to various challenges. Further research should expand to include other pedagogical skills, such as the use of technology-integrated learning models.

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