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What Is Shown by Bibliometric Analysis? A Review on Creativity Development in Science Class

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Abstract

The aim of this study is to provide an extensive bibliometric literature review on '*creative thinking skills*' and '*creativity*' in science classrooms. Articles were found by *Publishing or Perish* software (PoP) with *Google Scholar* (GS) database. There were 994 articles found from the GS database from 2010 to 2021, 498 articles were analyzed in this study. The selected references are then managed using reference manager software, namely *Zotero*. After managing the database, this research classifies and visualizes it using *VosViewer* software. Generally, the review provides an appropriate reference point for further research on the development of creativity and creative thinking skills in science classrooms. The keywords contained in network visualization and overlay visualization refer to the RADEC model as a contemporary teaching strategy that is expected to be able to build students' creativity and creative thinking skills in science class. Further research is needed to ensure that the RADEC model is a strategy capable of building students' creativity and creative thinking skills across academic and scientific levels.

Keywords: Bibliometric, Creativity, Creative Thinking Skills, Science Class, RADEC

Introduction

Digital transformation in the era of industrial revolution 4.40 and society 5.0 places creativity as an indicator of success (Cropley & Patston, 2019). Several researchers describe creativi7ty as the key to the digital revolution, including in the field of future learning innovation (Qian, Plucker, & Yang, 2019; Karwowski, et al., 2020). Students must have the creativity to be able to solve complex and uncertain problems that occur in everyday life (Gralewski & Karwowski, 2019; Jankowska, Gajda, & Karwowski, 2019; Beghetto, 2007). Vygotsky (in Hernández-Torrano & Ibrayeva, 2020) argues that if the main goal of schools is to prepare students for the future, then cultivating student creativity, should be one of the main forces listed to achieve this goal.

The implications of the inclusion of creativity as one of the skills that need to be trained in learning should encourage teachers to create effective strategies so that the output produced is reliable and creative for students (Qian, et al., 2019). Karwowski et al. (2020) mention that teachers have a key role in developing student creativity through interactive activities in the classroom. Teachers can choose learning strategies that invite students to generate many original ideas when solving problems in classroom situations (Kashani, et al. in Titikusumawati, et al., 2020). Furthermore, Ican (2019) suggests that teachers must set up a teaching environment that is relevant, challenging, and student-centered and guides the process of forming creative learners and becomes a model for

them. The tasks given are not just routine tasks that only follow strict instructions, but must trigger the emergence of creative solutions to the problems given (Amabile in Lucchiari, et al., 2019).

The implication of the inclusion of creativity development as one of the educational goals is to strengthen the position of teachers as the spearhead of learning with the main task of finding effective strategies to create a stimulating classroom atmosphere and build creativity in a sustainable manner (Qian, et al., 2019; Karwowski, et al., 2020 ; Erdem & Adiguzel, 2019). This indicates that there are various different strategies implemented by teachers in various countries in building student creativity, not least in the field of teaching science. The Partnership for 21st Century Skills (P21), Assessment and Teaching of 21st Century Skills (ATC21S), and the Organization for Economic Co-operation and Development (OECD) even explicitly stated that the development of creativity is a must in the 21st century. They also stated that the diversity of strategies adopted by teachers in teaching creativity is a certainty (Ananiadou & Claro, 2009).

This is because teacher perceptions influence teaching practices and teacher decisions (Hoge & Cudmore in Gralewski & Karwowski, 2019; Hong, et al. in Cropley, et al., 2019; Patston, et al. in Karwowski, et al., 2020) in planning, implementing, and evaluating learning which is the main task. Some researchers stated that teachers in Indonesia, especially science teachers have different perceptions in building student creativity. Only a small number of them adopt teaching strategies so that these strategies are in accordance with the conditions of students and the curriculum in Indonesia. Another fact states that most of the teachers in West Java say that they need extra time to understand the learning steps. Teachers even have a hard time remembering the syntax. This is not surprising because basically, the teaching strategies they have used so far are the product of the thoughts of foreign education experts who do not consider the condition of students and the curriculum in Indonesia. Therefore, it is necessary to have an analysis related to teaching strategies that are able to support the development of student creativity in Indonesia, including creativity in the science field.

There are various ways to construct learning strategies that are able to build student creativity, one of which is bibliometric analysis. Bibliometric is a software that can be used to analyze and look for gaps between creativity teaching strategies and the components that support the creation of student creativity. The step taken is to collect articles related to students' science creativity using *Publish or Perish* (PoP) software. The next step is to map the relationship between the components supporting the development of creativity contained in the title and abstract. In the end, several clusters of creativity keywords were obtained which are a way to find newness related to creative teaching strategies in Indonesia. This step is expected to be one way to obtain novelty in teaching strategies to improve reasoning to students, especially in the field of science.

Methodology

The study is a literary and systematic quantitative study. We used *Publish or Perish* to perform a bibliometric analysis and looked up the literature on creative thinking skills and creativity. The survey was conducted by conducting an online search using the keywords creative thinking skills and creativity, using title criteria and keywords in the subject area. The analysis consists of two steps. That is the analysis of research group keywords and article titles, and research topics using *Google Scholar* (GS) sources. GS was chosen because it proved to be the largest database and the most effective way to search for articles about GS, so *Publish or Perish* was chosen (Hudha et al., 2020).

A total of 994 articles related to creative thinking and creativity have been registered in the database. The next step is to filter and select articles from GS. International seminars, book reviews,

book reviews, book sections, and media comments are not selected. The filtered data is saved as a RIS file and imported into the *Zotero* bibliography tool. If the available data is incomplete, *Zotero* will check and correct components such as year of publication, volume, number, and page to obtain the necessary information. 498 articles received final results from 2010-2021.

The final step is to perform a surge analysis using the *VosViewer* software. The software can display visualizations of bibliographic networks that can work efficiently and provide a variety of interesting visuals, analyses, and exploration (Hudha et al., 2020; van Eck and Waltman, 2010). *Vosviewer* can also create publication maps, author maps or journal maps based on collaboration networks, or keyword maps based on shared networks.

Results and Discussion

The results of the bibliometric visualization show a network that presents the relationship between creativity, creative thinking skills, and science learning strategies contained in the article and shows how the topic has developed from year to year, one of which is related to the development of teaching strategies that stimulate students' creativity or creative thinking skills.

Figure 1 shows a network visualization of the keywords contained in the title and abstract. All of these keywords are connected to form a unique network that is able to map the linkages between research topics. Based on Figure 1, there are three clusters of research topics, each colored in green, blue, and red. The relationship between the three clusters is that both creativity and creative thinking skills are thinking skills that are always taught by teachers. The blue network cluster indicates that creativity is a thinking skill that requires collaboration in the process of its formation. Creative thinking skills are 21st-century skills that must be provided by science teachers in junior high schools through presenting creative problems as material content.

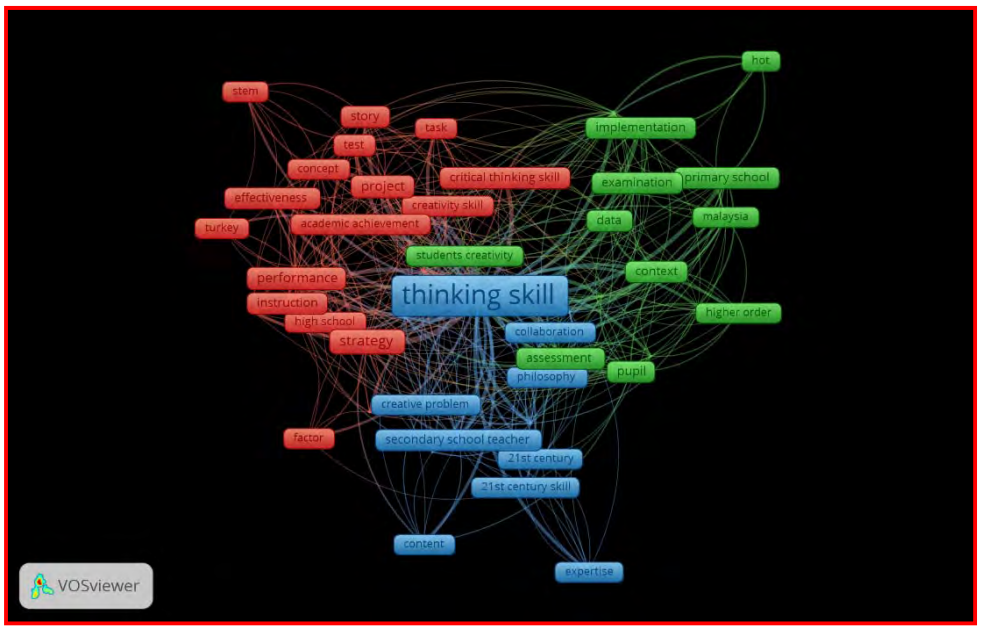

Figure 1. Network Visualization on Creativity in GS

Meanwhile, the green network cluster shows that creative thinking skills are thinking skills that describe creativity and higher-order thinking skills. What other people want to investigate re-

garding this is how they implement teaching strategies that can improve students' creative thinking skills. In addition, almost all researchers investigated how assessments or examinations were developed to measure students' creative thinking skills. Most of the research was carried out at the basic education level in Malaysia.

The red network cluster shows that thinking skills such as creative thinking are able to show performance skills and academic achievement. Most people research the strategies used to improve students' creative thinking skills. The strategy that is widely used in the STEM approach. Learning with the STEM approach involves projects, tasks, and giving a conceptual ability test. This research was mostly carried out in Turkey at the high school level and the tendency of what others want to know is its effectiveness compared to other strategies.

From the three clusters, there is one related keyword, namely content. The content referred to in-network visualization is related to the material that underlies the development of students' creative thinking skills, especially the fundamental concept of science. This indicates that building creative thinking skills and students' creativity requires a good mastery of concepts. The keyword teaching strategy that builds creativity never appears specifically, but based on critical analysis, information is obtained that to build students' creativity or creative thinking skills, a model or strategy is needed that facilitates students to read science content from various sources. However, it is more important than the method or model or method that must be based on the conditions of students and the curriculum in Indonesia.

Strategies, methods, or teaching models must be able to increase mastery of concepts because mastery of concepts is a fundamental creative thinking skill. The learning model that is considered suitable for all subjects, including science, is the *Read–Answer–Discuss-Explain–and Create* (RADEC) learning model. It is provided for students and teachers with the condition and curriculum in Indonesia. The RADEC learning model is one of the learning models that require students to be more active in learning. This model educates students to be more creative, innovative, and responsible in completing all matters related to learning. The stages of this learning model are in accordance with the letters, making it easy for teachers to understand. Thus, the RADEC learning model can make each student have a responsibility both individually and in groups, can interact personally, think critically, be able to solve problems, improve communication skills, improve the ability to cooperate, and improve mastery of concepts and creative thinking. Several research results show that the RADEC model can improve higher-order thinking and cross-level creativity (Handayani et al., 2019; Handayani et al., 2020; Siregar et al., 2018). The creation of this model provides an area of research covering the interest and reading ability of lecture participants and the factors that influence it such as mapping the actual development level (*Actual Development Level*), potential development level (*Potential Development Level*), analysis of the emergence and development of multiliteracy.

Besides being able to map networking between various keywords, bibliometric analysis is also able to track research trends from year to year for each keyword through visualization of different colors as shown in Figure 2. Based on Figure 2, information is obtained that the latest and most recent research is yellow which is still a research trend in 2020. The keywords are students' creativity, creativity skills, HOT, 21st-century skills, content, data, task, and effectiveness. This row of keywords means that it is still possible to develop a teaching strategy that develops students' creativity. This is because creative thinking skills or creativity are one of the 21st-century skills that indicate students' higher-order thinking skills. Previous researchers investigated strategies, methods, or models that investigate their effectiveness in developing creativity. Content, data, and tasks are instru-

ments used as supporting instruments or assessment tools in gathering student creativity. The RA-DEC learning model meets these criteria as a learning model that can build student creativity.

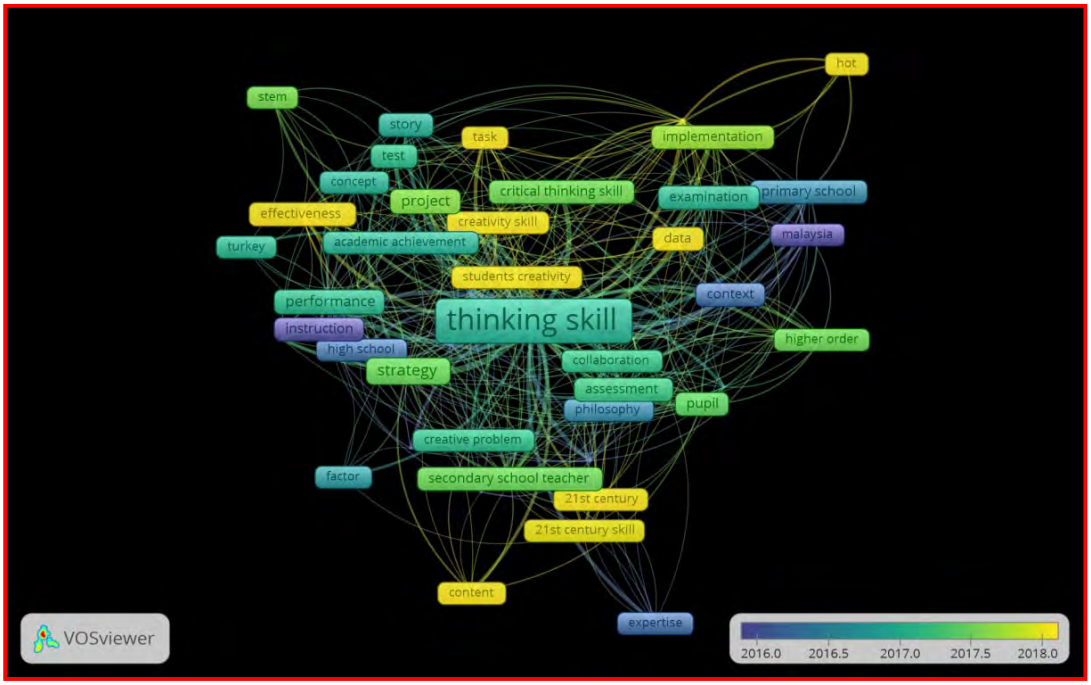

Figure 2. Network Overlays on Creativity in GS

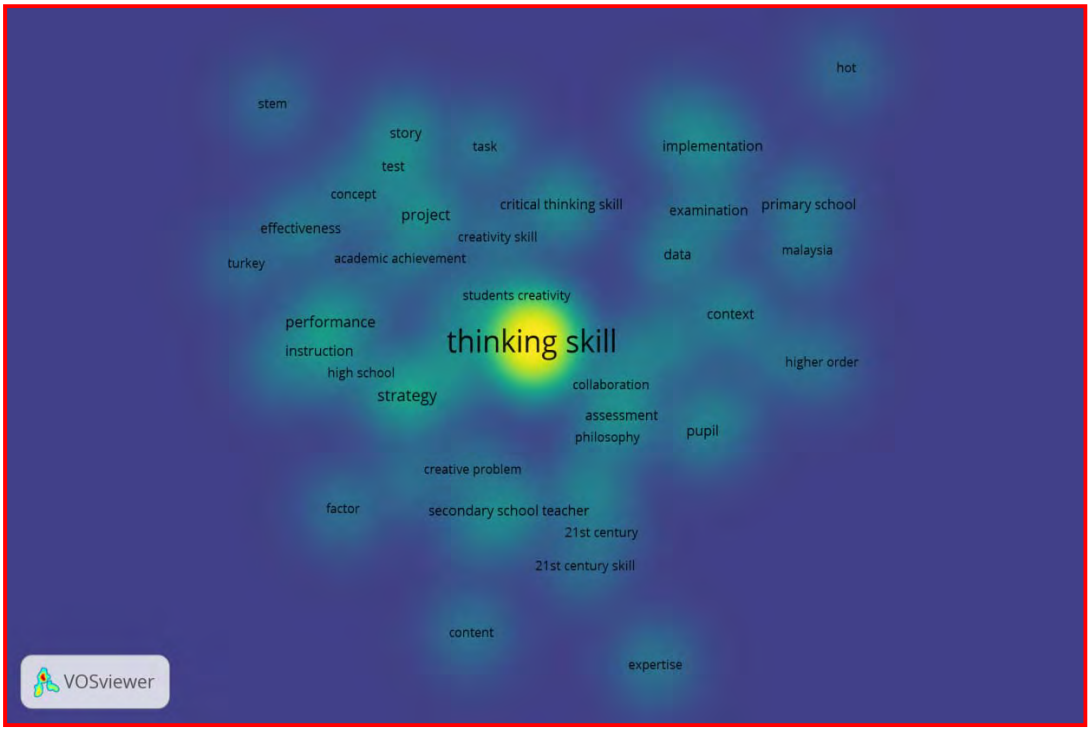

Figure 3. Density Visualization on Creativity in GS

Figure 1 and Figure 2 also provide important information that previously the development of student creativity was not supported by teaching strategies that provided literacy to students. Literacy is an important thing to be carried out by students as input to learn many new things. The RADEC learning model through its syntax facilitates students to read or rather forces students to read teaching materials before they engage in face-to-face or virtual learning in class. To ensure that this research is still relatively new, it can be seen in Figure 3 which indicates that the exploration of these keywords is still in the early stages. This indicates that new opportunities can still be found.

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Figure 3 shows that people tend to research thinking skills in general. The yellow color in the picture shows that due to the massive intensity of the research, thinking skills have been studied in depth. Meanwhile, for other keywords, research still has the opportunity to be developed. Research on all new keywords is in the early stages of research. this indicates that more research ideas are generated.

The results of bibliometric analysis using *VosViewer* do not explicitly mention a current strategy, method, or model to build student creativity. However, based on the keywords contained in network visualization and overlay visualization, a grid of strategies, methods, or models that are suitable to be developed in Indonesia is obtained. RADEC is Indonesia's national wisdom-based learning model that meets these criteria. The results of previous studies stated that in addition to being able to train or stimulate various cognitive abilities, this learning model can also be applied in various modes of learning (Lestari et al., 2021; Sujana et al., 2021; Sukardi, Sopandi, & Riandi, 2021b, 2021a; Sukardi, Sopandi, Sutinah, et al., 2021).

The interesting thing that can be traced from this model is that the RADEC model is a model that is easily applied by teachers in Indonesia (Fuadi et al., 2021; Satria & Sopandi, 2019; Setiawan et al., 2019). This is because the syntax of the RADEC learning model has been adapted to the needs of students and the curriculum in Indonesia. Besides, the learning syntax is also considered to be able to accommodate the development of students' abilities based on the perspective of the zone proximal development (ZPD). Therefore, RADEC deserves to be the choice of Indonesian educators in developing high-order thinking skills of students in Indonesia.

Conclusion

This study identifies journal articles whose themes are related to the keywords *creative thinking skills* and creativity in science class. Articles were collected from the GS database by PoP software. Then 498 articles published in the period 2010 to 2021 were selected for further analysis. The results of bibliometric analysis using VOSviewer show that research on the RADEC learning model is able to accommodate the needs and current research trends in Indonesia. The results of network visualization and overlay visualization do not show explicitly that the RADEC model is a creativity development strategy, but the keywords contained in it support the use of RADEC as a teaching strategy that implicitly builds student creativity in Indonesia.

Recommendation

The results of the bibliometric analysis show several keywords related to the development of student creativity. This analysis results in an assumption that the learning model that is able to accommodate the development of students' creativity in the field of science is the RADEC learning model. The RADEC learning model with all its characteristics and advantages has a high carrying capacity in building student creativity. However, to ensure that the RADEC learning model is able to develop students' creativity, the research must also be represented at various academic levels and across disciplines.

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