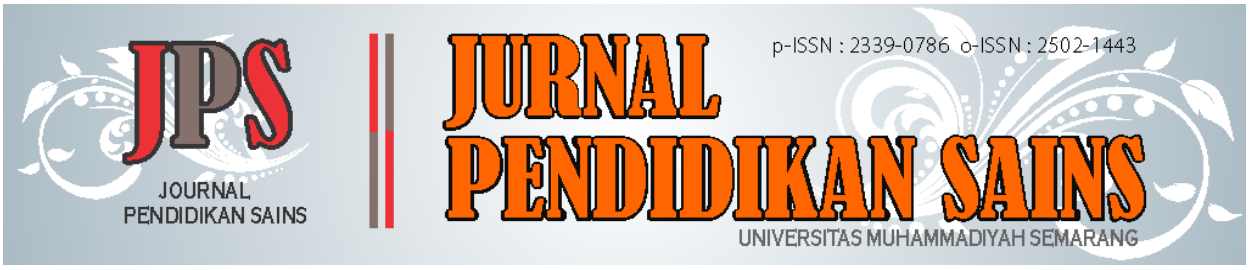
Jurnal Pendidikan Sains Universitas Muhammadiyah Semarang.
October Vol. 10(2) pp 53-62 ISSN:2339-0786
DOI: https://doi.org/10.26714/jps.10.2.2022.53-62



A Systematic Review of Adaptive Learning Research in Physics Education in Indonesia

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Article history
Submission : 2022-09-12
Revised : 2022-10-03
Accepted : 2022-11-02

Keyword
Adaptive learning
systematic review
Physics education
Indonesia

Abstract

This study aimed to map publication topics and research interests based on the author's keywords in an analysis of co-occurrence analysis from the Scopus database on adaptive learning research in physics education. This study used a systematic review method with primary data sources, namely, articles from scientific journals and proceedings indexed by Scopus from 2014 to 2021. Keyword restrictions were focused on adaptive learning with physics topics in Indonesia. The results of the study showed that the five main clusters related to adaptive learning, were machine learning, deep learning, algorithms, calculations, and students. Based on the results of the novelty analysis, areas becoming research trends in the realm of educational research were independent learning, instructional design, and curriculum to optimize adaptive learning. The results of this study could be used as a reference for further research focusing on developing and optimizing the potential of adaptive learning in Indonesia.

1. INTRODUCTION

Learning methods are developing into a new era that involves the use of technology in learning activities. The use of technology in learning is not something new in the world of education, especially in developed countries with adequate infrastructure support (Daim et al., 2018; Harrell & Bynum, 2018; Westbury, 2020; Williamson, 2019). It also shows optimal results in increasing student competence (Miranda et al., 2021; Nimavat et al., 2021; Romlah et al., 2021). Currently, information technology users in Indonesia have also experienced a significant increase (Kamil et al., 2021). This can be seen in the integration of information technology into the curriculum in each subject.

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The application of technology for classroom learning can change the paradigm from using conventional media to learning media based on information technology (Almeida & Simoes, 2019; Bylkova & Shalkov, 2020; Contreras et al., 2022; Goh & Abdul-Wahab, 2020; Kanwar et al., 2019). For example, the existence of e-learning as a technology-assisted learning media, both device-based and internet-based. E-learning is often used in the form of an online website that can be accessed by students anywhere and anytime. Thus, learning activities will be more effective and efficient and can increase student creativity through the use of e-learning-based media.

In addition to e-learning, a term that is often encountered in integrating information technology in learning is adaptive learning or also called adaptive teaching. Adaptive learning is a learning method that applies computers as interactive learning media (Mead et al., 2019; Safar et al., 2022; Vesin et al., 2018). The computer adjusts the learning materials presented according to the needs of the students. Students can carry out learning independently without any limitations of distance, space, and time. This concept makes students more creative, active, and independent because the technology designed can produce these competencies.

Learning physics, like other science learning requires much innovation to improve the quality of learning. In addition to the development of the physics scientific-framework, the research topic that is the focus of research related to physics education research is how to improve the quality of learning to produce optimal output (Krasnova & Shurygin, 2019; Kuswanto, 2018; Safar et al., 2022; Xie et al., 2022; Zulfiani et al., 2018).

Learning activities that are often an obstacle in learning physics are the implementation of practical activities. This does not only occur during the COVID-19 pandemic but also long before the online learning policy is issued. In addition, the topics discussed in physics lessons have relatively high abstractions, and sometimes the teacher is quite difficult to bring the phenomena being discussed into the classroom. Therefore, computer assistance as a simulation medium is the expected solution in optimizing physics learning (Darmaji et al., 2019; Guo, 2020; Maulidah & Prima, 2018; Pols, 2020).

Research related to adaptive learning has become the focus of many researchers around the world. However, adaptive learning is still something that has not been noticed. The optimization of learning by using adaptive learning has given many positive impacts in improving the quality of learning. Significant research differences can be an obstacle for Indonesian students in developing knowledge. The comparison between adaptive learning research in Indonesia and the world is shown in Figure 1.

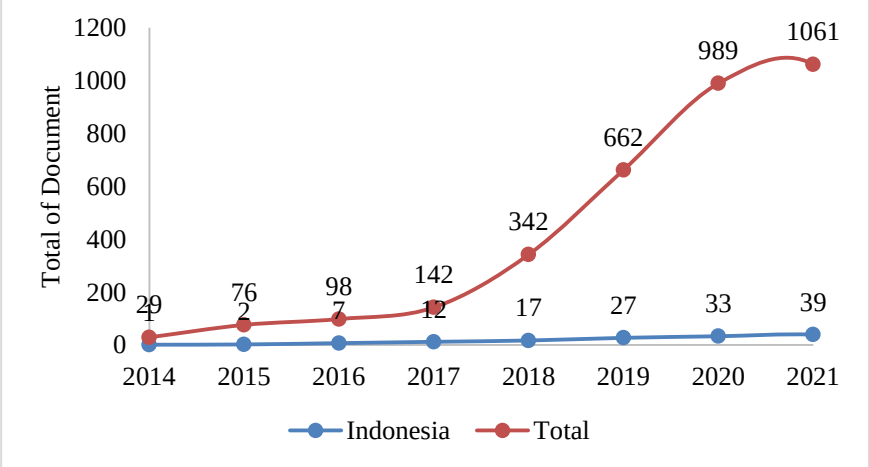

Figure 1. Comparison of Adaptive learning Research

To provide knowledge guidance related to adaptive learning research and its state of the art, a search has been carried out in this bibliometric study. The purpose is to assess the sources of publications and the widely discussed themes of adaptive learning. This study provides important information about emerging trends in research involving adaptive learning. It also identifies "hot spots" that may be of interest to researchers. The research question (RQ) used in this study is whether the topic of publication and research interest is based on the author's keywords in the analysis based on co-occurrence analysis.

2. METHOD

This study used a retrogressive approach, namely examining secondary data and materials or studies that had been carried out. Snyder suggests that a systematic or semi-systematic literature review, and secondary data review, provides a deeper understanding of the study phenomenon (Snyder, 2019). This approach ensures that studies are based on empirical events or supported evidence because only studies, including meta-analyses, that have been conducted are analyzed. Generally, qualitative research designs, combining qualitative content and thematic analysis are used to assess different ways. Thematic and content analysis requires conducting a thorough critique of each section of the text and identifying recurring themes from different text reviews, which then form the basis for conclusions and conclusions for descriptive studies (Snyder, 2019). This is the right research design and strategy considering the purpose of this study, to map the novelty of research related to adaptive learning in physics education in Indonesia.

The selection of articles started with searching for articles with the keyword "adaptive learning" on the Scopus page. The results showed that 99,868 documents discussed adaptive learning on Scopus. In the next stage, the researchers narrowed the search area to the context of physics and resulting in the publication of 10,890 articles. The search area was then narrowed down again to Indonesian territory with 153 documents produced. The last stage was to limit the study area to the last 9 (2014-2021) years with several documents obtained 144 documents. In more detail, the results of the selection and limitation of journal articles are listed in Table 1 and the sampling stages are shown in Figure 2.

Table 1. Types of Adaptive learning Research Publications in Indonesia

No	Category	Year							
		2014	2015	2016	2017	2018	2019	2020	2021
1	Journal	1	2	3	2	0	1	9	6
2	Article	-	-	4	10	17	26	24	33

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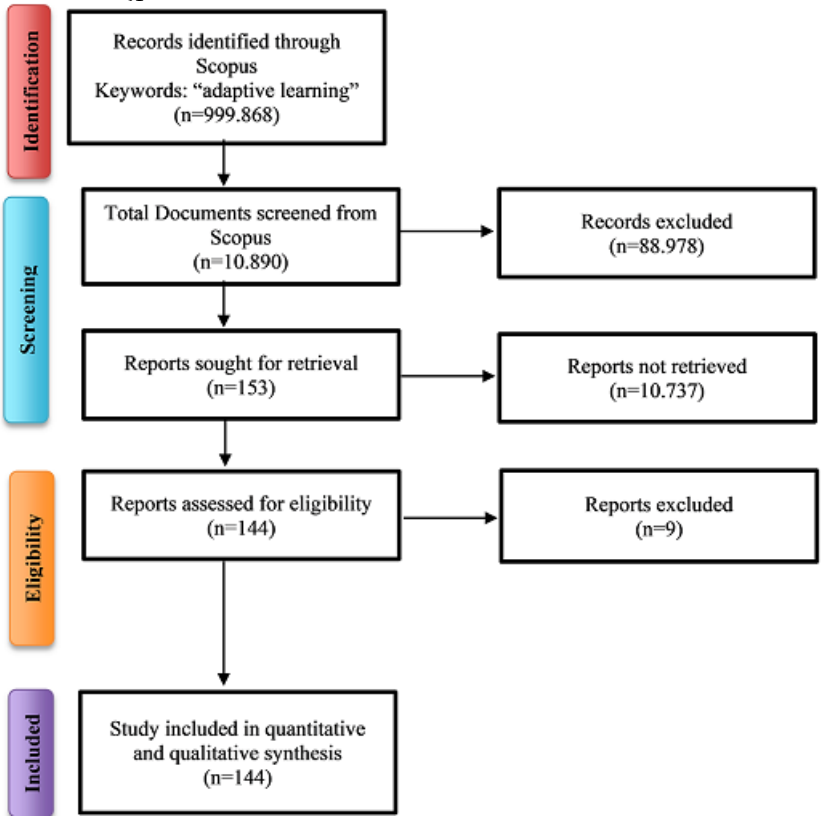

Figure 2. Data screening procedure

3. RESULTS AND DISCUSSION

The results of the primary publications and research interests based on the author's keywords in the co-occurrence analysis are presented in Figure 3. Through the co-occurrence analysis with the criteria for the minimum number of keyword occurrences = 3, then 91 of the 1374 keywords obtained to meet the threshold.

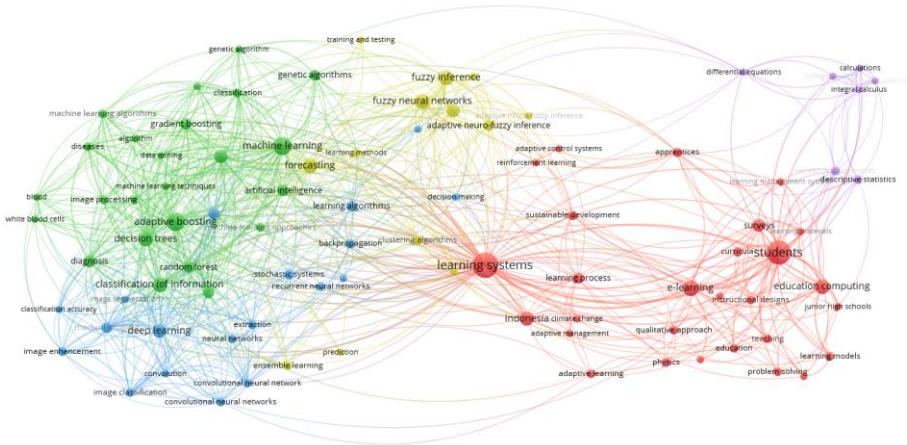

Figure 3. Research Patterns for Adaptive learning in Indonesia

Adaptive learning keywords obtained in Figure 3 were classified into five clusters. As expected, the most highlighted term, not only in cluster 1 but also across the network, was "Adaptive learning." Cluster 1 in adaptive learning research is shown in Figure 4.

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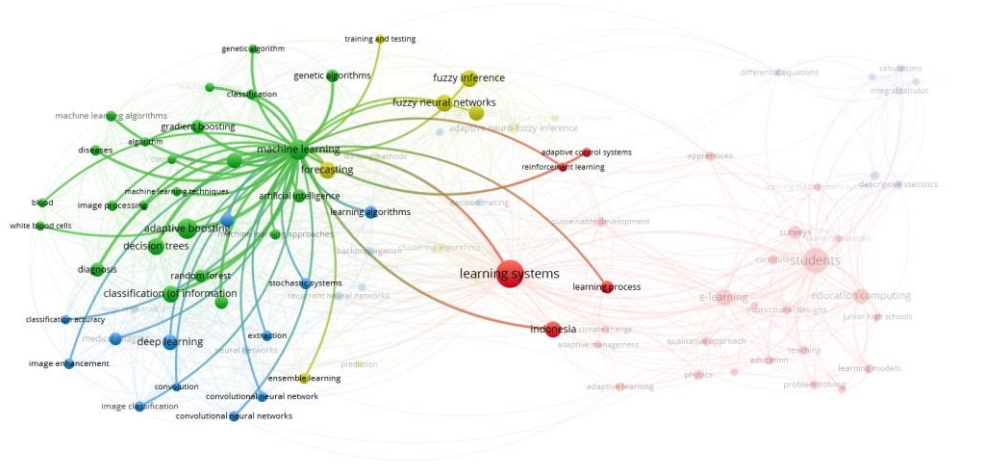

Figure 4. Cluster 1 Machine Learning

The main keywords represented in cluster 1 tended to focus on the application of Adaptive learning in the context of artificial intelligence, which consisted of adaptive boosting, data mining, image processing, and classification of information (Cluster 1 is marked in green). In addition, the focus in cluster 1 also included the implementation of adaptive learning in a health context. The next result was cluster 2, which was related to deep learning. The second cluster is shown in blue as shown in Figure 5.

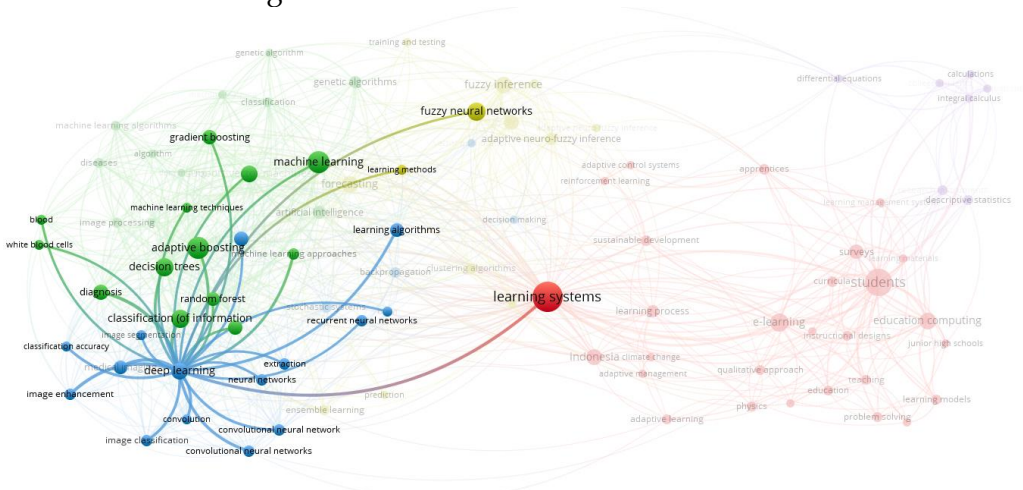

Figure 5. Cluster 2 Deep Learning

In cluster 2, the term that stands out was deep learning. Deep learning is a subfield of machine learning whose algorithms are inspired by the structure of the human brain. Machine learning techniques can be used in data mining in educational contexts, such as predicting student learning performance (Mou et al., 2021). These techniques can build predictive and descriptive models to find meaningful patterns and knowledge. For example, predictive models can predict student scores, whereas descriptive models can find new learning guides from large educational data. The use of this technique allows Intelligent Tutoring Systems (ITS) to suggest individual learning strategies. ITS can be classified into three categories: The next stage is the third cluster that highlights algorithms in adaptive learning. The third cluster is characterized by a yellow color as shown in Figure 6.

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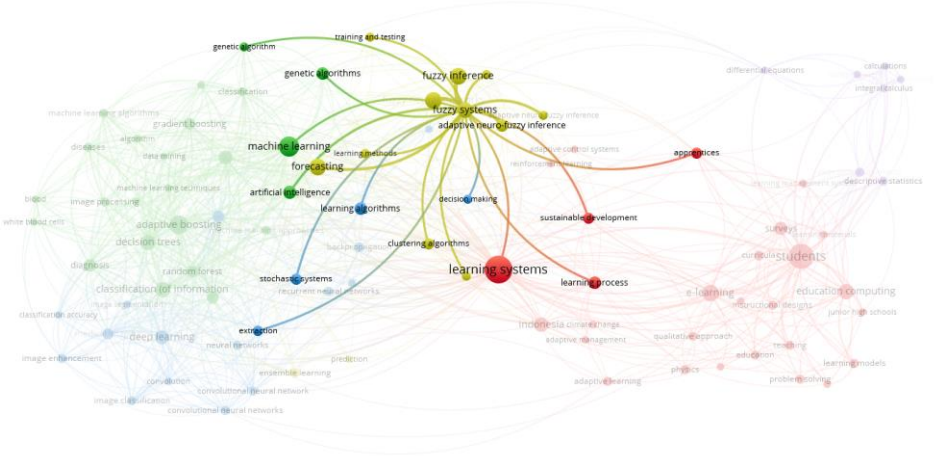

Figure 6. Cluster 3 Algorithm

Keywords that appeared in the third cluster tended to be very technical. The types of algorithms that appeared are the techniques used to design adaptive learning, such as fuzzy logic, prediction, forecasting, neo-fuzzy, and so on. These methods can be a reference for future researchers to develop systems related to adaptive learning. Alternatively, this pattern can also be an indication for researchers to find more effective models and algorithms for developing adaptive learning. In accordance with the third cluster, the fourth cluster more specifically shows the capabilities that adaptive learning developers and designers must possess. The fourth cluster is shown in purple, as shown in Figure 7.

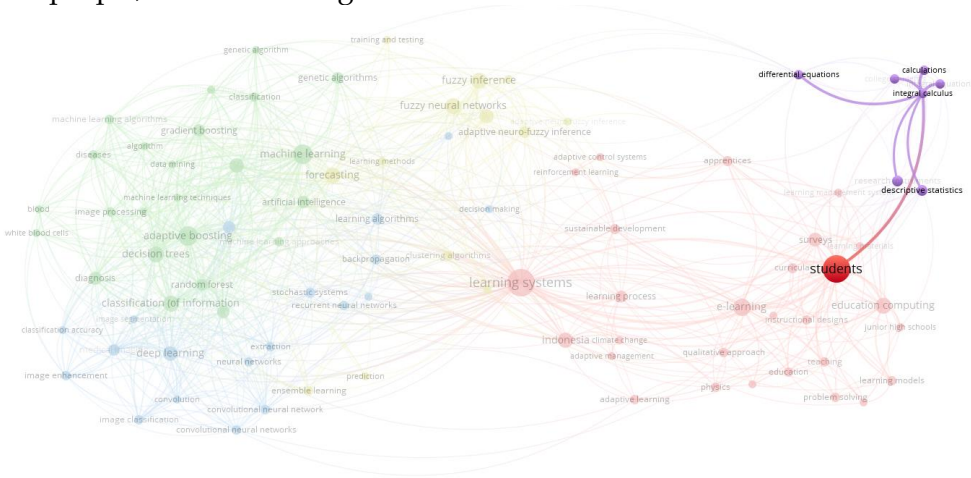

Figure 7. Cluster 4 Calculation

Figure 7 shows that the design of adaptive learning requires basic skills, such as statistics, calculus, integrals, and differentials. These basic abilities correlate with the development method described in cluster 3. Finally, in the fifth cluster, the results of the student component analysis were the primary part. The fifth cluster is shown in red, as shown in Figure 8.

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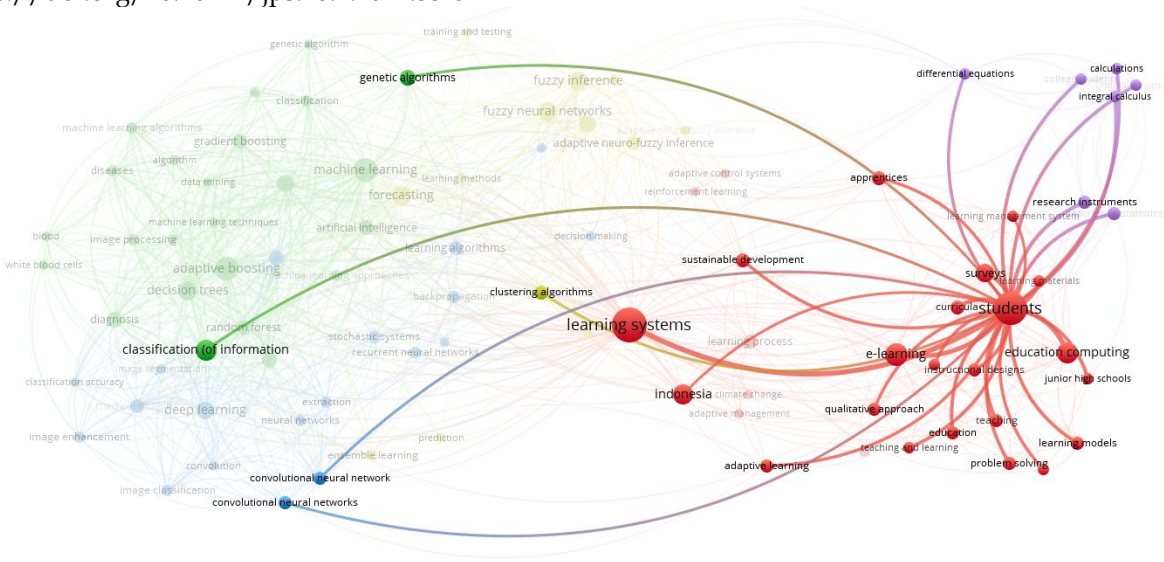

Figure 8. Cluster 5 Student

Figure 8 shows the research area related to students as the main keyword. Research in student clusters is related to learning models, problem-solving, e-learning, computing, and instructional design. This is an illustration that adaptive learning cannot stand alone, and still requires assistance from the pedagogical aspect in its development. Thus, adaptive learning models prepared through computer programs can still facilitate students' thinking skills as users, not just students as developers.

The ultimate goal of this research is to provide information about state-of-the-art research related to adaptive learning. Information about the pattern of research development related to adaptive learning is shown in Figure 10.

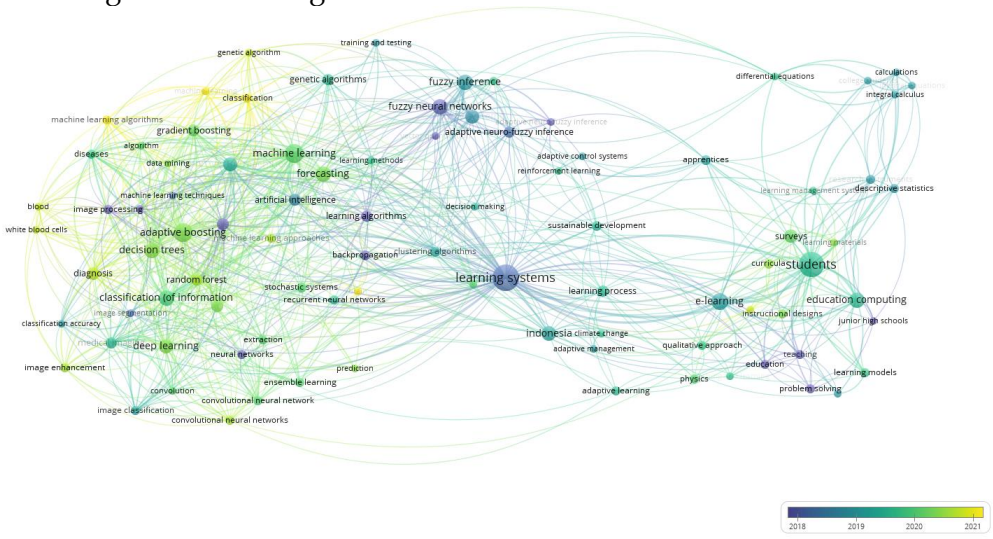

Figure 10. Adaptive learning research development from year to year

Figure 10 indicates that the pattern of research on learning systems is quite old. The same thing with research on algorithms as in the third cluster. In the last two years, the focus of research has tended to focus on clusters one, two, four, and five. In the first and second clusters, the current focus of recent research relates to the health area. This is reasonable considering that much research in the last two years has been diverted to studying COVID-19 and its treatment (Angeli & Montefusco, 2020; Bohmrah & Kaur, 2021; Farooq & Bazaz, 2020; Gaur et al., 2020; Meeter, 2021). Focusing on adaptive learning in an educational context, the mapping results are shown in Figure 11.

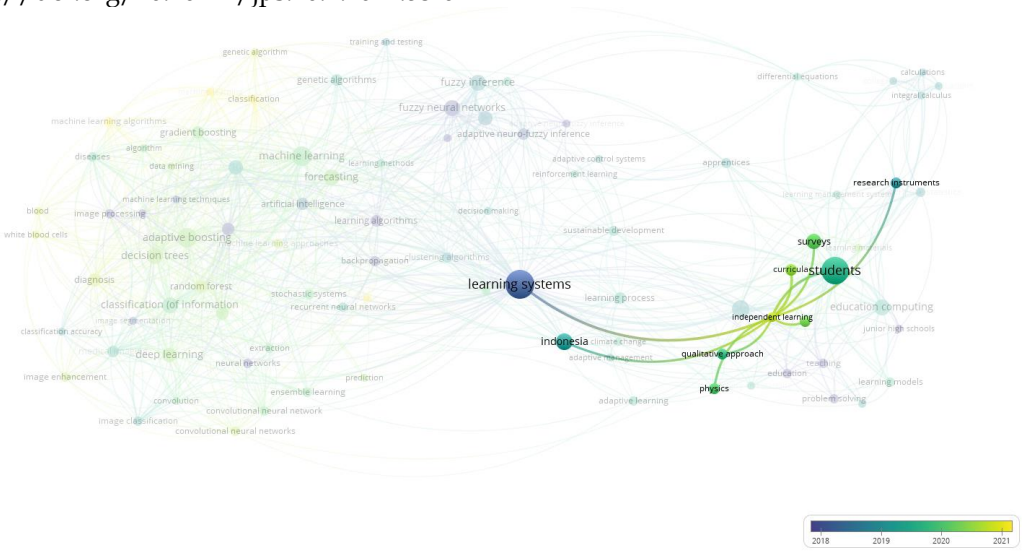

Figure 11. Recent research in student cluster

Figure 11 shows that the novelty of research on adaptive learning in the context of any discipline including physics education is optimizing independent learning, such as the use of Massive Open Online Courses (MOOCs), e-modules, live worksheets, Web Quest, etc. (Clark & Kaw, 2020; Liu et al., 2018; Wang et al., 2020; Yakin & Linden, 2021), instructional design, such as project-based learning, problem-based learning, inquiry-based learning (Cavanagh et al., 2020; Wang et al., 2020), and curriculum such as Curriculum 2013 and Curriculum "Merdeka"(Barcelona, 2014; Forbes & Davis, 2010; Leask & Bridge, 2013; Marzano, 1988; Millar, 2008). These provide opportunities for further research because many studies show that adaptive learning can be a solution to overcoming gap learning.

4. CONCLUSION

In the last decade (2014-2021), the number of publications on adaptive learning increased periodically. Keyword analysis showed that in studies on adaptive learning in the last two years, the research focus tended to focus on the health area. The novelty of the research on adaptive learning in the context of physics education was optimizing independent learning, instructional design, learning materials, and curriculum. The bibliometric analysis presented relevant information about the main themes studied about adaptive learning.

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