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The Trends Research of Conceptual Mastery in Students' Physics Learning (2015-2024): A Systematic Review

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Abstract: To support the improvement of 21st century skills, students must have good concept mastery first. This is in accordance with one of the goals of education is to master the concepts studied. Mastery of concepts is important for students to have because it can determine the level of success of students in participating in learning activities and whether the teacher is successful or not in fostering enthusiasm, encouragement, interest and student learning outcomes with classroom management. This research aims to identify and analyze research trends in the conceptual mastery in physics learning. This research method is descriptive and analytical. The data used in this research was obtained from documents indexed by Google Scholar from 2015-2024 using Publish or Perish and Dimension.ai. Research procedures use PRISMA guidelines. The data identified and analyzed are the type of publication, publication source, and the title of research on conceptual mastery in physics learning that is widely cited. The data analysis method uses bibliometric analysis assisted by VOS viewer software. The results of the analysis show that the trend of research on the conceptual mastery in physics learning indexed by Google Scholar from 2015 to 2024 experienced a fluctuating increase. However, in 2023 there will be a decline in the research trend on conceptual mastery in physics learning. There are many documents in the form of articles, proceedings, book, chapters, edited books and monograph that discuss research into the conceptual mastery in physics learning. Keywords that are often used in research of conceptual mastery are conflict cognitive approach, discovery model, STEM, effectiveness, etc.

Keywords: Conceptual mastery; Physics learning; Review

Introduction

Increasing the standards and quality of education is one of the strategies implemented by government as a response to the era globalization currently being faced. Effort to improve educational standards aims to create human resources excellence that can be identified through mastery of 21st century skills by every individual. Significance of skills the 21st century has made it a focus major in current educational research (Geisinger, 2016). This is caused by the importance of 21st century skills as preparation of students in facing various future challenges (Larson et al., 2011) and had a substantial impact on students' lives after them complete their formal education (Kaufman, 2013). The implementation 21st century skills are considered to be a must in every process learning (Dicerbo, 2014; Fry et al., 2011; Griffin, 2017; Jang, 2016; Lambert et al., 2010; Sibille et al., 2010). To support the improvement of 21st century skills, students must have good concept mastery first. This is in accordance with one of the goals of education is to master the concepts studied.

Mastery of concepts is important for students to have because it can determine the level of success of

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students in participating in learning activities and whether the teacher is successful or not in fostering enthusiasm, encouragement, interest and student learning outcomes with classroom management. The provision of education that continues to develop shows that student learning outcomes are often far from assessment standards. One of the contributing factors is that students find it difficult to master learning concepts.

Concept mastery is a student's ability to understand a concept or phenomena studied after learning activities (Lodge et al., 2018). When students master a concept well, the student not only understands but has it a solid foundation for thinking, such as being able to identify, give examples, apply concepts that are mastered in solving a problem, and can even understand the concept new (Badruzzaman et al., 2019; Nugraha et al., 2016). Concept mastery is the process of absorbing knowledge by students during the learning process which can be seen from the results obtained from student learning outcomes at the end of learning.

Mastery of science concepts is a student's ability to overcome science concepts at the level of student cognitive development in accordance with Bloom's revised classification in the cognitive domain. Mastery of concepts can be viewed from the cognitive process dimensions proposed by Bloom. Where the cognitive process dimensions are remembering (C1), understanding (C2), applying (C3), analyzing (C4), evaluating (C5), and creating (C6) (Himmah et al., 2019). Students are considered to have mastered a concept that has been taught if they can translate it from an abstract state to another state, from a symbolic form to another form or vice versa, and can interpret in the form of the ability to organize existing data according to the individual's own views (Siahaan et al., 2020). Students' conceptual mastery must be improved in all branches of science, one of which is physics.

Physics subjects at the SMA/MA level require students to achieve competency in the form of mastery of concepts. Students in SMA/MA should be able to master knowledge so that you can participate in secondary education optimal. Learning physics material should be done to be able to do it facilitate students in achieving optimal mastery of concepts (Abdurrahman et al., 2018; Jamilah et al., 2020; Saprudin et al., 2017).

Students' optimal mastery of concepts in learning is expected to be able to implement physics concepts in daily life and activities (Dewi et al., 2018). Students' mastery of concepts obtained in the physics lesson process is the ability to understand physics concepts after the learning process. According to Kusumah et al. (2020), understanding the meaning of physics scientifically, both theoretical mastery and students' ability to apply concepts in everyday life is part of students' concept mastery so that students who have studied physics are expected to be able to master the concepts of physics material that have been taught and be able to apply it in everyday life.

Based on research conducted by Chou et al. (2020), the results showed that 57% of students did not have good concept mastery. Students' critical thinking abilities and mastery of concepts are quite low in science learning (Ramdani et al., 2020). This is proven by the low learning outcomes obtained by students. Student learning outcomes influence students' critical thinking abilities and mastery of concepts (Zulkarnain et al., 2019). This is greatly influenced by the ability of the teacher's role in managing learning in successfully achieving the goals to be achieved (Nugraha et al., 2016).

Therefore, this research wants to know the research trend of the conceptual mastery. It is hoped that this research can become a reference in developing further research related to conceptual mastery in students' physics learning.

Method

This research method is descriptive and analytical, which aims to understand and describe research trends in the conceptual mastery in physics learning. The data used in this study was obtained from information sources indexed by Google Scholar using analytical tools such as Publish or Perish and Dimension.ai. To carry out a search on Google Scholar, keywords related to research trends on the conceptual mastery in physics learning. In this research, an analysis was carried out on 1,000 documents that had been indexed by Google Scholar between 2015 and 2024.

The Google Scholar database was chosen as a place to search for documents because Google Scholar applies consistent standards in selecting documents to be included in its index, and Google Scholar displays more documents than the top others databases, especially research in the field of education (Hallinger et al., 2019, 2020). To filter data that has been collected via Publish or Perish, researchers used the Preferred Reporting Items for Systematic Reviews and Meta-Analyses (PRISMA) guidelines.

Result and Discussion

This research aims to describe research trends on conceptual mastery conducted from 2015 to 2024. Research documents on research trends conceptual mastery in physics learning are taken from documents from 2015 to 2024. Figure 1 is presented below regarding research trends on the conceptual mastery in physics learning.

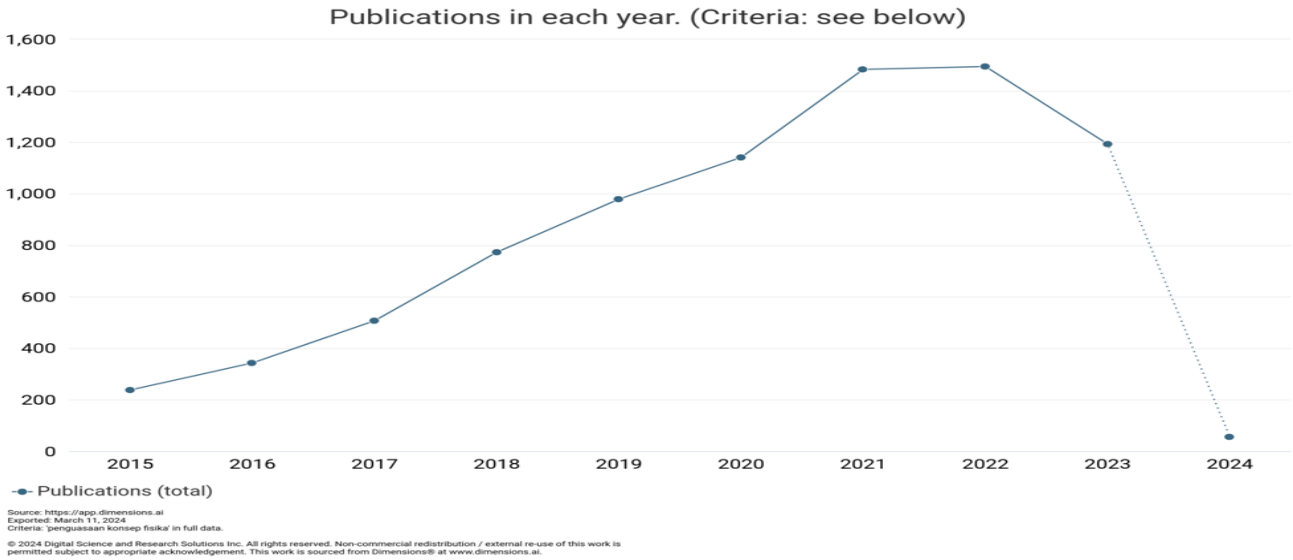

Figure 1. Research trends in conceptual mastery in physics learning

Figure 1 shows that the trend in research on the conceptual mastery in physics learning from 2015 to 2024 has increased. Where the research trend is with an increase in the number of publications every year, namely from 2015 to 2022. However, in 2023 the research trend on the conceptual mastery in physics learning has decreased. The increasing trend in research on the conceptual mastery in physics learning caused by conceptual mastery is one of the goals of education (Hermansyah et al., 2021; Sulman et al., 2022; Winarto et al., 2022). In 2015 there were 238 publications related to the conceptual mastery in physics learning, then this will continue to increase to 1.49 publications in 2022. This increasing research trend provides a deeper understanding the problem which is low of conceptual mastery in physics learning and ways to solve that problem. Research is able to improve conceptual mastery through various methods. Below are also presented research of conceptual mastery in physics learning based on the type of publication.

Based on Table 1, it is known that research conceptual mastery in physics learning from 2015 to 2024 contained in 6 types of publications. In the form of articles there were 8.25 documents, proceedings as many as 194 documents, edited books as many as 58 documents, chapters as many as 25 documents, preprint as many as 17 documents and monographs as many as 11 documents. Research trends conceptual mastery in physics learning in article form is the type of publication that contains the most research about conceptual mastery in physics learning compared to other types of publications. Meanwhile, the type of publication contains the least amount of research results conceptual mastery in physics learning is a monograph. Research conducted by Oltarzhevskyi (2019), and Dwivedi et al. (2023), states that an article is a complete factual essay of a certain length created for publication in online or print media (via newspapers, magazines or bulletins) and aims to convey ideas and facts that can convince and educate. These articles are usually published in scientific journals both in print and online (Suseno et al., 2020).

Table 1. Trends in Conceptual Mastery in Physics Learning Research Based on Publication Types

Publication Type	Publications
Article	8.25
Proceeding	194
Edited Book	58
Chapter	25
Preprint	17
Monograph	11

Below are also presented top ten (10) sources title trends in research on conceptual mastery in physics learning which are often cited by other researchers related to this matter.

Table 2 shows that the most widely published source of research trends on the conceptual mastery in physics learning is the Jurnal Penelitian Pendidikan IPA, namely 145 publications with 185 citations and an average citation of 1.28. Jurnal Penelitian Pendidikan IPA contains scientific articles form of research results that include science, technology, and teaching in the field of science. The first edition were published in 2015. All edition in this journal are open access. The articles published in them are immediately and permanently free to read, download, copy & distribute. Below are also presented top ten (10) article title trends in research on conceptual mastery in physics learning which are often cited by other researchers related to this matter.

Table 2. Top 10 Sources Title Trend of Conceptual Mastery in Physics Learning Research in 2015-2024

Name	Publications	Citations	Citations Mean
Jurnal Penelitian Pendidikan IPA	145	185	1.28
Journal of Physics Conference Series	140	605	4.32
Advances in Social Science, Education and Humanities Research	120	123	1.03
Jurnal Basicedu	113	439	3.88
Jurnal Pendidikan Fisika	109	178	1.63
Edukatif Jurnal Ilmu Pendidikan	99	283	2.86
Jurnal Penelitian Pembelajaran Fisika	98	156	1.59
Jurnal Ilmiah Profesi Pendidikan	96	193	2.01
INPAFI (Inovasi Pembelajaran Fisika)	96	94	0.98
Jurnal Pendidikan Teori Penelitian dan Pengembangan	86	189	2.20

Table 3 shows that research on the conceptual mastery in physics learning that is widely cited by other researchers is about "Hybrid Learning Model: Its Impact on Mastery Of Concepts And Self-Regulation In Newton's Second Law Material" which is 8.50 (Sulman et al., 2022). Then the research entitled "The Effect of Predict-Observe-Explain (POE) Strategy on Students' Conceptual Mastery and Critical Thinking in Learning Vibration and Wave" was cited 7.17 times per year (Alfiyanti et al., 2020). Research by Harjono et al. (2020) entitled "An Interactive e- Book for Physics to Improve Students' Conceptual Mastery" is also widely cited by other researchers, namely 6.25 per year. Ramdani et al. (2020) in their research entitled "The effectiveness of physics learning tools based on discovery model with cognitive conflict approach toward student's conceptual mastery" was cited 6.00 per year.

Table 3. Top 10 Citations on Trend of Conceptual Mastery Research in 2015-2024

Cites/year	Year	Author	Title
8.50	2022	Fauzan Sulman, Lia Yuliati, Sentot Kusairi, Arif Hidayat	Hybrid Learning Model: Its Impact on Mastery of Concepts and Self-Regulation in Newton's Second Law Material
7.17	2018	Furqani, Dandy; Feranie, Selly; Winarno, Nanang	The Effect of Predict-Observe-Explain (POE) Strategy on Students' Conceptual Mastery and Critical Thinking in Learning Vibration and Wave
6.25	2020	Ahmad Harjono, Gunawan Gunawan, Rabiatul Adawiyah, Lovy Herayanti	An Interactive e- Book for Physics to Improve Students' Conceptual Mastery
6.00	2021	G Gunawan, K Kosim, I Ibrahim, S Susilawati, A Syukur	The effectiveness of physics learning tools based on discovery model with cognitive conflict approach toward student's conceptual mastery
5.56	2015	J Maknun	The Implementation of Generative Learning Model on Physics Lesson to Increase Mastery Concepts and Generic Science Skills of Vocational Students
4.75	2020	S M Dewi, G Gunawan, A Harjono, S Susilawati,L Herayanti	Generative learning models assisted by virtual laboratory to improve mastery of student physics concept
2.60	2019	Drikben Eka Putra Nggadas, Ariswan Ariswan	The mastery of physics concepts between students are learning by ICT and laboratory experiments based-teaching
2.00	2021	Susilawati, Ahmad Hardjono, Lalu Muliyadi, Christine P. Abo	Development of Physics Learning Media based on Guided Inquiry Model to Improve Students' Concepts Mastery and Creativity
1.50	2022	Susilawati, Baiq Arum Kusumayati, Sutrio Sutrio, Aris Doyan	Practicality of Learning Devices Based on Conceptual Change Model to Improve Concept Mastery of Students in the Gas Kinetic Theory Material
1.50	2022	Rahayu Laelandi, A. Widodo, S. Sriyati	Depth of Science Learning Materials in Schools and Student Concept Mastery

This research data is comparable to data on the increasing trend of research on the conceptual mastery in physics learning from 2015 to 2024. This means that in that year, research related to the conceptual mastery in physics learning was continuously cited by other researchers. In the articles researched and written by these researchers, there are many terms related to conceptual mastery. Below are presented ten (10) popular keywords related to conceptual mastery.

Table 4. Keywords on Trend of Conceptual Mastery in Physics Learning Research in 2015-2024

Terms	Occurences	Relevence
Cognitive conflict approach	5	6.81
Discovery model	5	6.81
STEM	7	2.09
Virtual Laboratory	6	1.40
POE	6	1.25
Physics concept	6	1.24
Effectiveness	20	0.94
Interactive E book	6	0.85
Gender	5	0.77
Critical thinking skill	9	0.65

Table 4 shows that the keywords that often appear related to research on the conceptual mastery in physics learning are effectiveness 20 times with a level of 0.94. This indicates that conceptual mastery in physics learning are often researched when measuring the effectiveness of a development product, for example, research conducted by Gunawan et al. (2021), Serevina et al. (2021), and Susilawati et al. (2022) which examined the effectiveness of physics learning tools based on discovery model with cognitive conflict approach toward student's conceptual mastery. Table 4 also shows that critical thinking skill is also a keyword that appears frequently in research trends on the conceptual mastery in physics learning, namely 9 times with a relevance of 0.65. This indicates that conceptual mastery in physics learning are often researched together with critical thinking skills, for example, research conducted by Zulhelmi et al. (2023) which examined The Effect of Predict-Observe-Explain (POE) Strategy on Students' Conceptual Mastery and Critical Thinking in Learning Vibration and Wave.

Below are the visualization is accomplished by generating a landscape map, which offers a visual representation of subjects related to scientific studies (Boström et al., 2022; Lindquist et al., 2016; Roth, 2021). The outcomes of bibliometric mapping for the co-word network in articles related to the topic conceptual mastery in physics learning are illustrated in Figure 2.

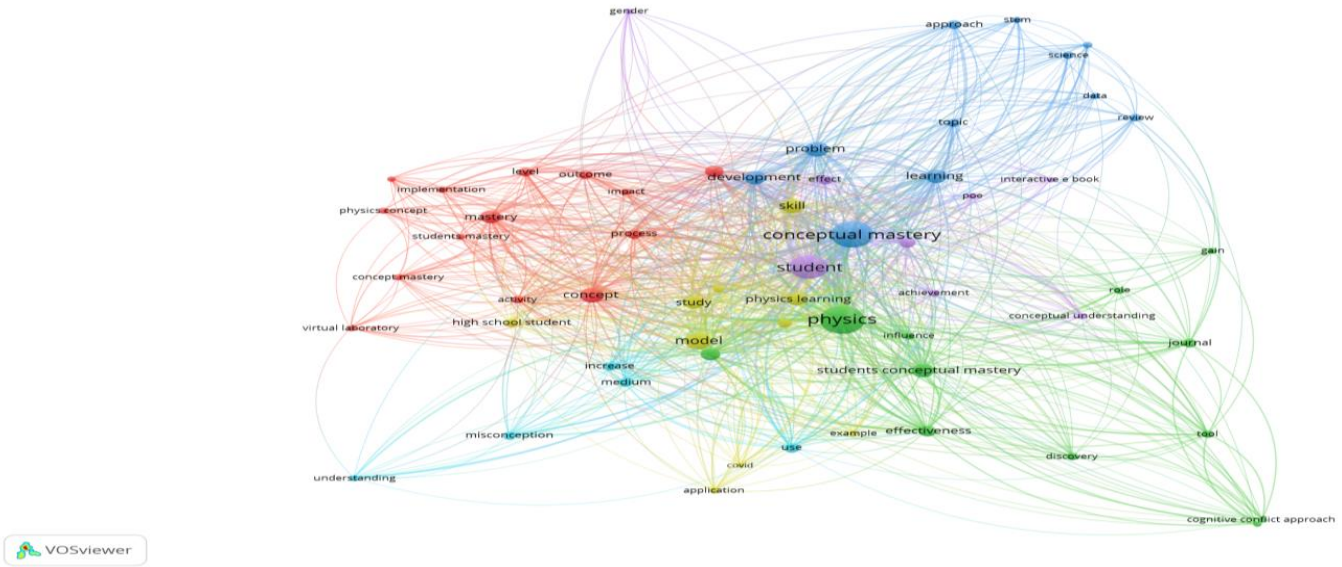

Figure 2. Network visualization on trend conceptual mastery in physics learning research

Figure 2 shows the results of bibliometric keyword mapping on research trends on the conceptual mastery in physics learning. In Figure 2 there are 1257 terms and 60 keyword items that are often used in research on the conceptual mastery in physics learning from 2015 to 2024. Figure 2 also contains 6 clusters, where the first cluster is colored red and consists of 14 keyword items, namely virtual laboratory, concept, analysis, implementation, etc. The second cluster in green consists of 12 keyword items, namely cognitive conflict approach, discovery, effectiveness, etc. The third cluster in blue consists of 11 keyword items, namely science, STEM, problrm, etc. The fourth yellow cluster consists of 10 keyword items, namely covid, critical thinking skills, teacher, high school student, etc. The fifth purple cluster consists of 8 keyword items, namely gender, interactive e book, POE, conceptual understanding, etc. The last cluster consist of 5 keyword items, namely misconception, medium, etc.

Figure 2 above also shows that network visualization shows the network between the terms being visualized. Keywords classified into six clusters are arranged in a color chart showing the divisions that are connected to each other. The results of this analysis can be used to determine keyword research trends in the last year. This analysis shows several keywords that are

often used in research on the conceptual mastery in physics learning (Thahir et al., 2020). The more keywords that appear, the wider the visualization displayed. Below are also presented keywords regarding the conceptual mastery in physics learning based on overlay visualization.

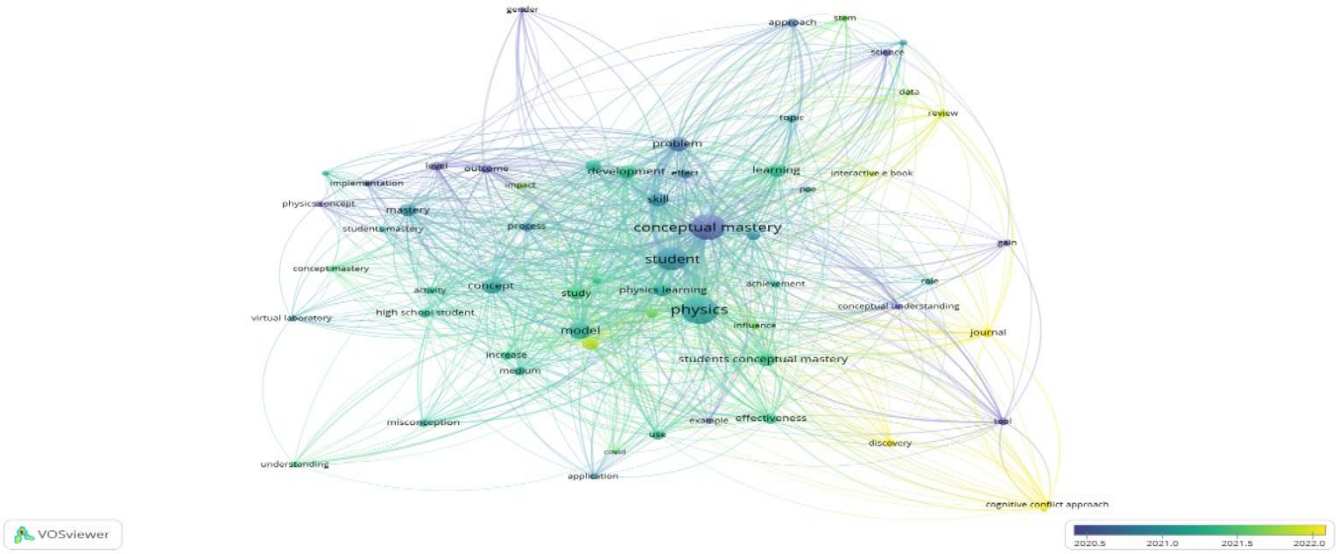

Figure 3. Overlay visualization on trend conceptual mastery in physics learning research

Figure 3 shows the trend of keywords related to research on conceptual mastery in physics learning in Google Scholar indexed journals from 2015 to 2024. Trends in the themes of writing articles related to the conceptual mastery in physics learning from the oldest to the newest year are marked with purple, blue themes, turquoise, dark green, light green and yellow. In the picture above you can see that the conceptual understanding, gender, outcome, implementation, etc. This shows that these keywords were widely used by researchers in 2020. In 2021, the keywords that frequently appeared were misconception, development, medium, application, etc.

While in 2022, the keywords that frequently appeared were cognitive conflict approach, dicvovery, ability, etc. Research on conceptual mastery in physics learning is one area of research that has developed rapidly in recent years. The following also presents keywords for conceptual mastery in physics learning research based on density visualization.

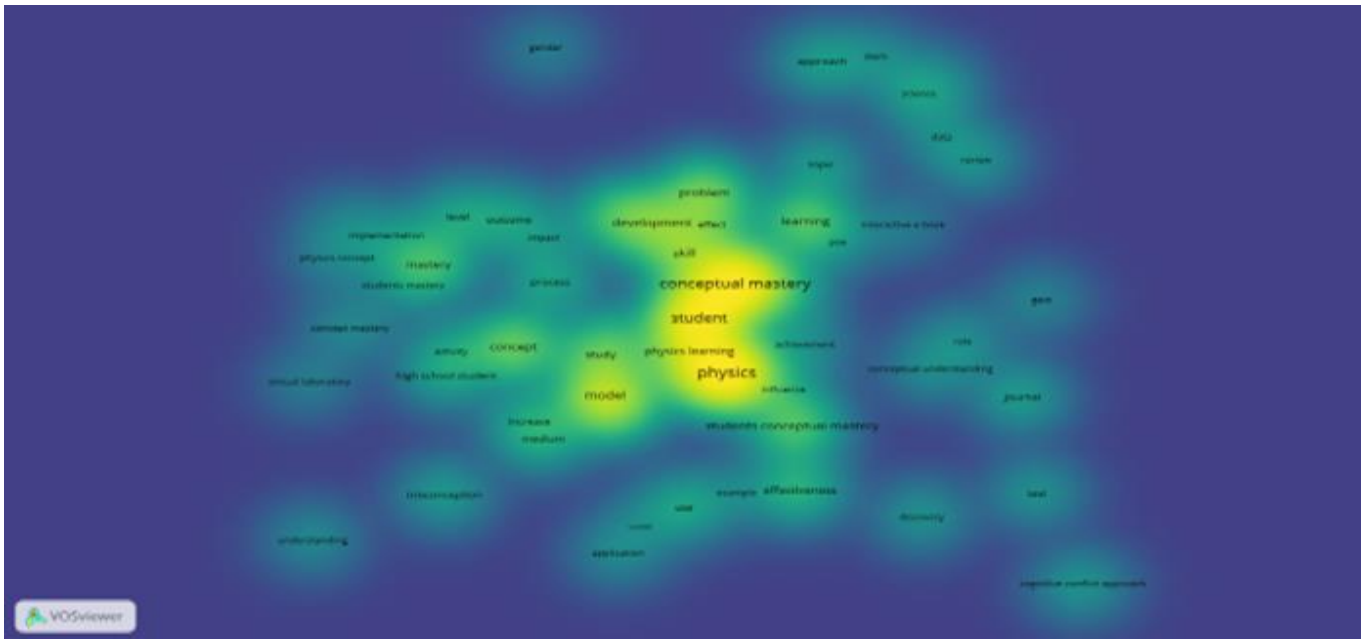

Figure 4. Density visualization on trend conceptual mastery in physics learning research

Figure 4 shows density visualization. The density of research themes is shown in bright yellow. The brighter the colors of a theme, the more research is done. The fainter the color means the theme is rarely researched (Kaur et al., 2022; Liao et al., 2018). Faintly colored themes such as gender, tool, POE, level are dimly colored keywords. This shows that these keywords can be used as a reference for further research. Doyan et al. (2023) and Bahtiar et al. (2023) stated that yellow indicates keywords that are currently and frequently used in research.

Overall, research on conceptual mastery in physics learning is important because it makes significant contributions to the 21st century education. To support the improvement of 21st century skills, students must have good concept mastery first (Faraniza, 2021; Parmini et al., 2023; Prayogo, 2022). This is in accordance with one of the goals of education is to master the concepts studied. Mastery of concepts is important for students to have because it can determine the level of success of students in participating in learning activities and whether the teacher is successful or not in fostering enthusiasm, encouragement, interest and student learning outcomes with classroom management (Darling-Hammond et al., 2020; Mebert et al., 2020; Smiderle et al., 2020).

The research trend in conceptual mastery in physics learning is expected to continue to develop in the next few years. This can be done by developing new learning models, media or learning tools to facilitate students' conceptual mastery, especially in physics subjects.

Conclusion

Research on trends in the conceptual mastery in physics learning has urgency high because of its potential to provide various benefits to 21st century education. The research trend on the conceptual mastery in physics learning indexed by Google Scholar from 2015 to 2024 has experienced a fluctuating increase. However, in 2023 there will be a decline in the research trend on conceptual mastery in physics learning. There are many documents in the form of articles, proceedings, book, chapters, edited books and monograph that discuss research into the conceptual mastery in physics learning. Key words that are often used in research of conceptual mastery are conflict cognitive approach, discovery model, STEM, effectiveness, etc.

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Author Contributions
Conceptualization; A. D.; methodology.; S.; validation; formal analysis; S. A.; investigation.; L. M; resources; R. R. P. M; data curation: M. I.; writing—original draft preparation. S. B.; writing—review and editing: R. A. H.; visualization: N. R. A. All authors have read and agreed to the published version of the manuscript.

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Conflicts of Interest
The authors declare no conflict of interest.

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