PILLAR OF PHYSICS EDUCATION
Vol. 19 (3), 2026, page.317-332
ISSN (Print) : 2337-9618
ISSN (Online) : 2684-8880

MAPPING TRENDS IN RESEARCH ON PHYSICS MISCONCEPTIONS IN HIGH SCHOOLS IN INDONESIA: A BIBLIOMETRIC ANALYSIS

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ABSTRACT

This study analyzed research trends in high school physics misconceptions in Indonesia from 2020 to 2025 using a bibliometric approach with an exploratory descriptive design. Physics education aimed to develop students' conceptual knowledge, scientific skills, and holistic potential. Through Publish or Perish (PoP), 253 relevant articles were identified, and 50 were selected for bibliometric analysis. The publication volume increased steadily over the six-year period: 2020 (25 articles, 9.88%): Focused on developing diagnostic tests like Three-Tier and Four-Tier Tests using the Certainty of Response Index (CRI). 2021 (34 articles, 13.44%): Evaluated conceptual understanding during COVID-19 online learning. 2022 (40 articles, 15.81%): Emphasized misconception remediation using models like Cognitive Conflict, Predict-Observe-Explain (POE), and Discovery Learning. 2023 (47 articles, 18.58%): Centered on learning adaptations and diagnostic assessments under Kurikulum Merdeka. 2024 (53 articles, 20.95%): Incorporated digital media, technology, and Computer-Based Tests (CBT). 2025 (54 articles, 21.34%): Reached peak publications, expanding into Systematic Literature Reviews (SLR) across various physics topics. VOSviewer network analysis showed that atomic concepts formed a major research cluster, led by atomic structure (40%), atomic nuclei (30%), radioactive decay (20%), and other topics (10%). Keyword co-occurrence analysis yielded 898 total links, indicating strong term connectedness. The central keyword was "Bibliometric Analysis," recording 89 occurrences, 49 links, and a total link strength of 412.

Keywords : Physics Misconception, Senior High School, Bibliometric, VOSviewer, Publish Or Perish

I. INTRODUCTION

Physics education at the Senior High School (SMA) level aimed to teach conceptual knowledge and scientific skills, as well as to develop learning characters that were beneficial to students' lives. Fundamentally, education was an essential process that developed students' potential holistically. By equipping individuals with cognitive, affective, and psychomotor competencies, students were able to understand basic concepts that served as the foundation of science, apply that knowledge in daily life, and solve problems scientifically. Some students whose cognitive development had not fully reached the formal stage experienced difficulties in formulating and understanding abstract concepts. Therefore, physics concepts were initially explained through real-world phenomena before students were guided to formulate them more formally. Ideal physics learning required a process of mastering formulas and correcting conceptual understanding, while mathematical formulas served as representations of concepts. For instance, the use of images, graphs, or analogies that were not consistent with scientific concepts caused misconceptions, particularly when scientific concepts were expected to be intelligible (easy to understand), plausible (reasonable and aligned with scientific evidence), and fruitful (useful for explaining various phenomena and solving new problems) [1] [2].

To improve the quality of physics learning, teaching materials and learning approaches capable of helping learners build accurate conceptual understanding were required. This demonstrated the importance of developing physics teaching materials that integrated new literacies. This indicated that physics learning was not only directed toward concept mastery, but also needed to be connected with learners' abilities to understand and apply physics knowledge in various contexts of life [3]. Previous research revealed that high school students faced various

obstacles in suboptimal learning processes, such as differences in students' prior knowledge, limited learning time, and the use of learning strategies that were oriented toward achieving end results rather than developing thinking processes [1] [4].

The issue of misconceptions was not merely an instructional problem, but also became an evolving research object that needed to be mapped so that trends, patterns, research gaps, novelties, and research directions regarding physics misconceptions in Indonesia could be identified using databases and the VOSviewer application. Thus, researchers were able to analyze publication developments, document types and sources, affiliations, research trend mappings, leading authors, and the most frequently cited publications [5] [6]. In this study, the researchers conducted a bibliometric analysis using the Publish or Perish application on scientific publications from the previous five years, specifically covering the 2020–2025 period. Searches were conducted through the Crossref, Semantic Scholar, and Google Scholar databases. After the filtering process was completed based on the inclusion criteria and irrelevant articles were removed, the dataset was analyzed using VOSviewer through a co-occurrence approach to map relationships between keywords and identify major research topics related to high school physics misconceptions in Indonesia.

This method was chosen because it provided researchers with a mapping outcome that functioned as a roadmap for identifying rarely explored research gaps. These findings served as a foundation for conducting newer, more innovative, and targeted studies. For educators, this comprehensive overview provided evaluation material for designing a more responsive and effective physics curriculum by offering deeper insights into the physics topics that most frequently caused misconceptions, as well as the diagnostic and remediation methods that were most widely used.Based on the foregoing discussion, this research was entitled "Mapping Trends in Physics Misconception Research at Senior High School in Indonesia: A Bibliometric Analysis Using VOSviewer".

II. METHOD

This study employed a quantitative approach with an exploratory descriptive design focused on bibliometric analysis. This design aimed to comprehensively map research trends regarding physics misconceptions at the high school level in Indonesia. Through bibliometric analysis, this study sought to identify publication patterns, research focus areas, and dominant methodological developments in the latest scientific literature [7]. This method was chosen to provide a comprehensive, objective, and measurable overview of the research landscape on physics misconceptions in Indonesia. Bibliometric analysis enabled the identification of influential publications, frequently occurring keywords, and collaboration networks among researchers and institutions, all of which contributed to a deeper understanding of the dynamics of this field of study [8]. The method used was purposive sampling, in which the researchers intentionally selected articles that met predetermined inclusion criteria to ensure the focus and depth of the analysis [7]. The study consisted of six research stages, as shown in the following figure.

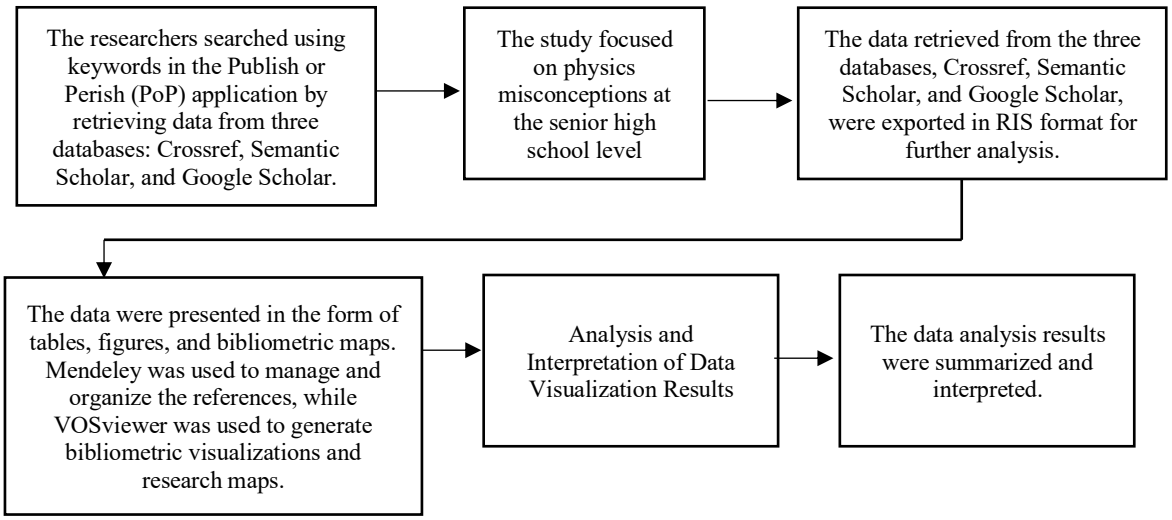


Fig. 1. Bibliometric Research Workflow

The data collection technique was conducted through a systematic search of the Crossref database using predetermined specific keywords. The keywords used included "Miskonsepsi fisika SMA," "Misconception physics high school Indonesia," and other relevant variations. The searches were conducted repeatedly to ensure data completeness and minimize the risk of missing important articles. After the articles had been collected, the bibliographic data were exported in Research Information Systems (RIS) format, which included information on

titles, authors, publication years, journals, abstracts, and keywords. The data were then screened manually based on the inclusion and exclusion criteria through title and abstract screening [9]. The eligible articles were subsequently downloaded and stored in a local database for further analysis.The PRISMA (Preferred Reporting Items for Systematic Reviews and Meta-Analyses) method was used by the researchers to obtain relevant articles for further analysis. The process of selecting and collecting data using the PRISMA method was divided into four stages: identification, screening, eligibility, and inclusion [9]. The process of applying the PRISMA method was described as follows:

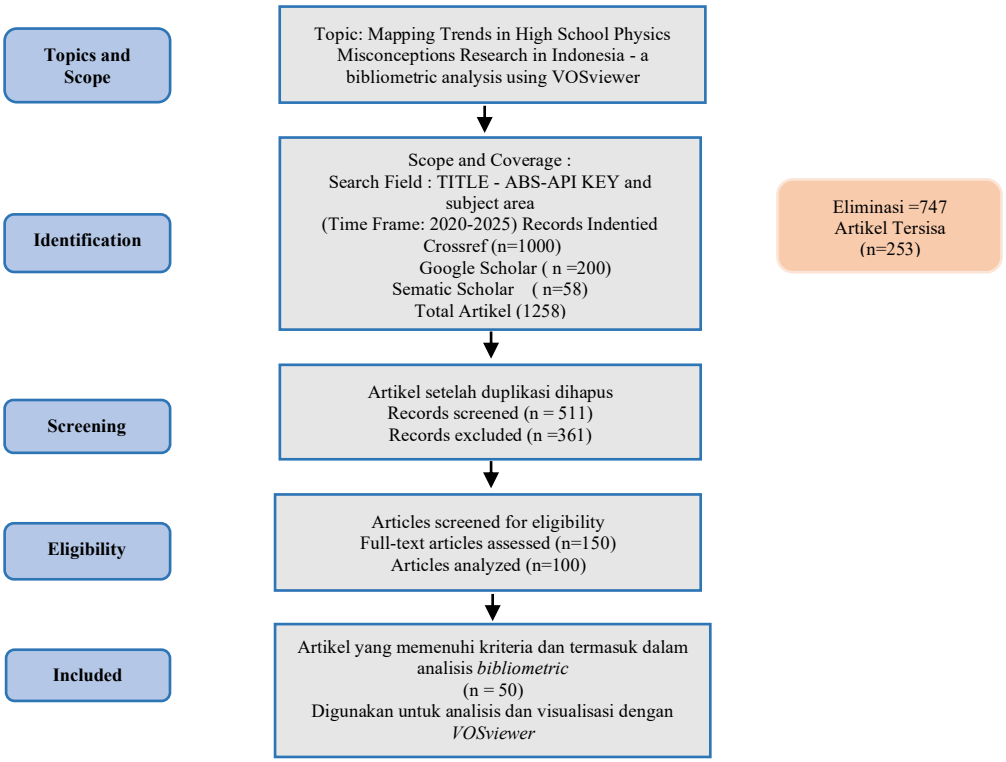


Fig. 2. The Data Collection Process in the PRISMA Diagram

The article inclusion and exclusion process was conducted systematically based on the PRISMA flow. During the identification stage, a total of 1,258 articles were retrieved from various databases. Subsequently, 747 articles were eliminated because they did not meet the initial research criteria, leaving 511 articles for the screening process. During the screening stage, the articles were assessed based on their titles and abstracts, and 361 articles were excluded because they were not relevant to the focus of the study. Subsequently, 150 articles were assessed for eligibility through a more in-depth full-text examination. The assessment showed that 100 articles did not meet the eligibility criteria, resulting in 50 articles that fulfilled all inclusion criteria. The eligible articles were then included in the bibliometric analysis and visualized using VOSviewer.

III. RESULTS AND DISCUSSION

A. Annual publication

The keywords extracted from the article metadata were collected, reviewed, and standardized to minimize variations in the spelling and terminology of terms with similar meanings, such as *"misconception," "physics misconception,"* and *"miskonsepsi fisika."* This standardization process was performed to improve the consistency of the dataset and ensure that the co-occurrence analysis using VOSviewer generated a more accurate and representative visualization of the relationships among the identified concepts. Keywords with higher frequencies of occurrence and stronger linkages were subsequently examined to identify frequently occurring research themes, patterns in research development, and potential areas for further investigation. The results of the preliminary statistical analysis were presented using frequency distribution tables, publication trend graphs, and descriptive statistical summaries. These results provided an overview of the characteristics and distribution of research on high school physics misconceptions in Indonesia before the subsequent bibliometric analysis was conducted using VOSviewer. The preliminary statistical analysis therefore provided a quantitative basis for interpreting the bibliometric visualization and facilitated a more systematic and comprehensive examination of the research landscape.

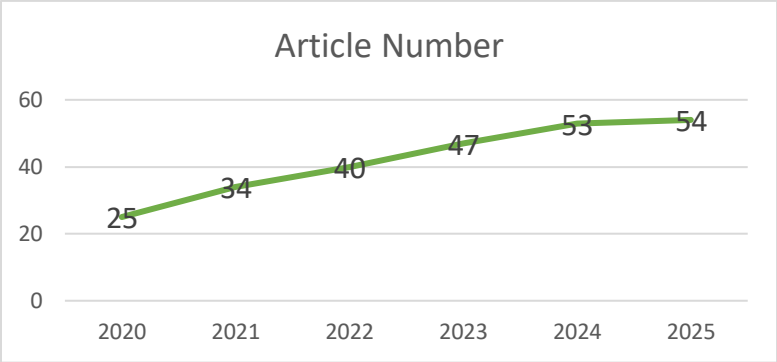


Fig. 3 Publication Trend in Physics Misconception Research (2020–2025)

Table.1 Distribution by Year of Publication

No	Year	Number of Articles (f)	Percentage (%)	Research Trends & Key Focus Areas
1.	2020	25	9.88 %	The foundation of diagnostic tests (such as the CRI-based Three-Tier or Four-Tier Test) lies in fundamental subjects (Mechanics, Electricity).
2.	2021	34	13,44 %	A Surge in Online Learning Research: Evaluating High School Students' Conceptual Understanding During the COVID-19 Pandemic.
3.	2022	40	15.81 %	Remediation of Misconceptions: The Application of Learning Models (Cognitive Conflict, POE, Discovery) to Reduce Misconceptions in the Post-Pandemic Era
4.	2023	47	18,58 %	The Merdeka Curriculum Transition focuses on initial diagnostic assessments and the development of interactive/digital assessment tools.
5.	2024	53	20,95 %	Development of digital-based/CBT instruments, integration of AI or digital learning media for automatic detection.

6.	2025	54	21,34 %	Advanced Study & Systematic Literature Review (SLR): Mapping the Effectiveness of Cross-Topic Misconception Reduction Methods in High School
Total		253	100,00	

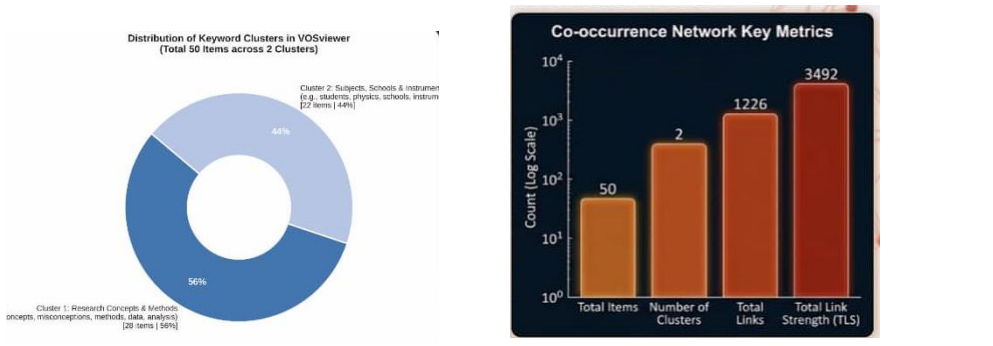
Based on the mapping of research publications on physics misconceptions at the senior high school level during the 2020–2025 period, 253 articles were obtained that met the research criteria**.** The distribution of articles by publication year showed an increasing trend in the number of studies over the years. In 2020, 25 articles (9.88%) were published. This number increased to 34 articles (13.44%) in 2021 and further increased to 40 articles (15.81%) in 2022. The number of publications continued to increase in 2023, reaching 47 articles (18.58%)**.** Furthermore, 53 articles (20.95%) were published in 2024, while the highest number of publications was recorded in 2025**,** with 54 articles (21.34%)**.** Thus, the number of publications increased by 29 articles between 2020 and 2025, meaning that the number of publications in 2025 was more than twice the number recorded in 2020**.** Descriptively, this pattern indicated that research on physics misconceptions at the senior high school level received increasing attention throughout the 2020–2025 period. The increase in publications also indicated that misconception research was not limited to misconception identification but had expanded to the use of diagnostic instruments, remediation strategies, assessment, and digital technology in physics learning.

B. Map or Visualization of the Research Network on Physics Misconceptions

Based on the results of the analysis using VOSviewer, the research network on physics misconceptions among high school students was examined through co-authorship and co-occurrence analyses. The co-authorship analysis provided an overview of the collaborative relationships among authors, while the co-occurrence analysis illustrated the relationships among keywords in the publications. In the co-authorship analysis, variations were found in the number of documents and the strength of relationships among authors. Several authors had relatively high numbers of publications and Total Link Strength, whereas other authors had more limited collaborative relationships. This condition indicated that the research network on physics misconceptions among high school students had not been evenly distributed and that several authors had been more prominent within the collaboration network.

Meanwhile, the co-occurrence analysis identified 50 items that formed a keyword network consisting of 2 clusters, 1,226 links, and a Total Link Strength of 3,492. These results indicated that various research topics related to physics misconceptions had been interconnected. Keywords related to students, physics, concepts, misconceptions, research, methods, data, analysis, schools, and instruments indicated that research on physics misconceptions had not only focused on identifying conceptual errors but had also been related to research subjects, the physics concepts being studied, diagnostic methods, and data analysis processes.

Thus, the VOSviewer visualization provided an overview of the structure of the research network and the interconnectedness of research themes concerning physics misconceptions among high school students in Indonesia.

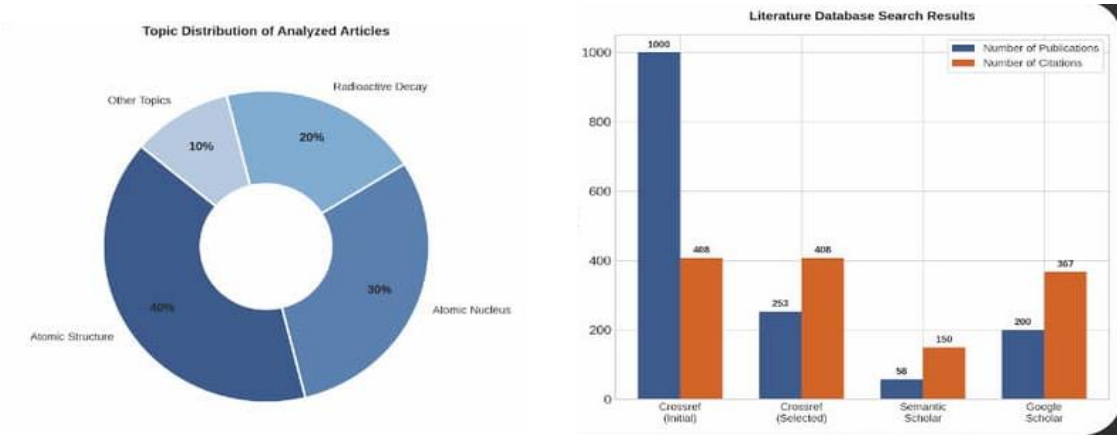


(a) (b)

Fig. 4 (a) Distribution of Keyword Clusters in VOSviewer (b) Main Metrics of VOSviewer Co-occurance network

C. Topic Distribution and Database Search Results

Apart from the VOSviewer keyword analysis, the topic distribution of the analyzed articles shows that atomic structure represents the largest proportion at 40%, followed by atomic nucleus at 30%, radioactive decay at 20%, and other physics topics at 10%. The database search yielded 1,000 publications with a total of 408 citations from *Crossref*. After applying inclusion criteria and removing irrelevant studies, 747 articles were eliminated, leaving 253 articles that met the research criteria. Additionally, *Semantic Scholar* produced 58 publications with 150 citations, while *Google Scholar* generated 200 publications with 367 citations. These publication datasets were subsequently analyzed using VOSviewer through a co-occurrence approach to map relationships among keywords and identify key research themes in high school physics misconceptions in Indonesia, identifying 50 keywords across a network with 1,226 links and a Total Link Strength of 3,492.



(a) (b)

Fig. 4 (a) Topic Distribution of Analyzed Articles (b) Literature Database search Result

D. Analysis of Topic Trends Using VOSviewer

A total of 50 articles that met the inclusion criteria were analyzed using VOSviewer software. The analysis was conducted through two approaches, namely co-authorship and co-occurrence. The co-authorship analysis was used to identify collaboration patterns among authors in physics misconception research, while the co-occurrence analysis was used to identify the co-occurrence of keywords within the articles. Keywords that frequently appeared together indicated relationships among the topics discussed in the research. The VOSviewer mapping results were used to identify the main topics, relationships among topics, and research clusters concerning physics misconceptions at the SMA/MA level in Indonesia. The keyword network was presented in the form of network visualization, while the development of topic occurrences over the years was analyzed through overlay visualization.

a. Interpretation of Network Visualization

The network visualization showed the relationships among keywords in the form of a network. Keywords with larger circles indicated a higher frequency of occurrence. Keywords that were positioned closer to each

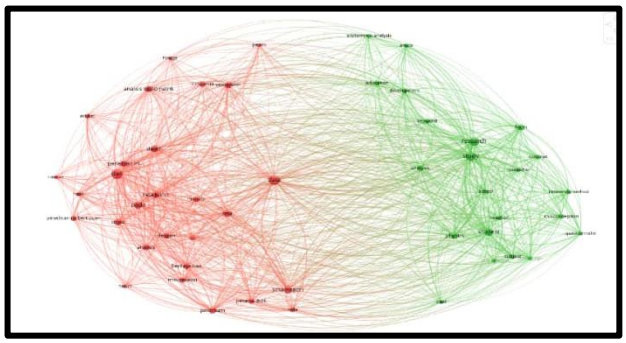


Fig. 5 Network Visualization

other indicated stronger relationships, while the connecting lines indicated that the keywords had appeared together in several articles. Based on the results of the network visualization generated using

VOSviewer, the topic of misconceptions about atomic concepts formed one of the research clusters related to conceptual understanding, diagnostic tests, atomic structure, the atomic nucleus, and radioactive decay. The relationships among these keywords indicated that research on misconceptions regarding atomic concepts had not only focused on students' misunderstanding of atomic structures and components but had also included the use of diagnostic instruments to identify specific forms of misconceptions more precisely.

b. Interpretation of Overlay Visualization

Overlay visualization was used to examine the development of research topics based on publication years. The colors in the visualization indicated the average time of keyword occurrences. Older colors represented topics that had been widely discussed during the earlier periods, whereas newer colors represented relatively recent topics. Based on the results of the overlay visualization, research topics in the earlier periods tended to focus on the identification of misconceptions, conceptual understanding, and basic physics concepts. In subsequent periods, the research developed toward the use of tiered diagnostic instruments, the analysis of misconception profiles, and the development of learning strategies aimed at reducing misconceptions.

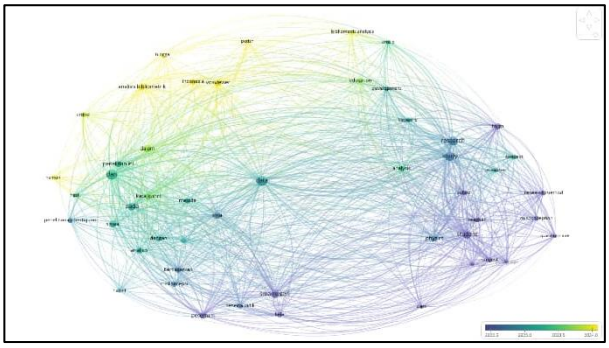


Fig. 6 Network Visualization

c. Author Co-Authorship Analysis: Principal Investigator Contribution

The co-authorship analysis was conducted to map collaboration patterns and identify the main researchers who had made significant contributions to the research ecosystem on physics misconceptions among high school students in Indonesia. The analysis was performed using VOSviewer software. The co-authorship relationships were represented by connections among authors' names, while the strength of the collaborative relationships was indicated by the Links and Total Link Strength (TLS). The analysis consequently produced a network consisting of 50 authors who met the established criteria.

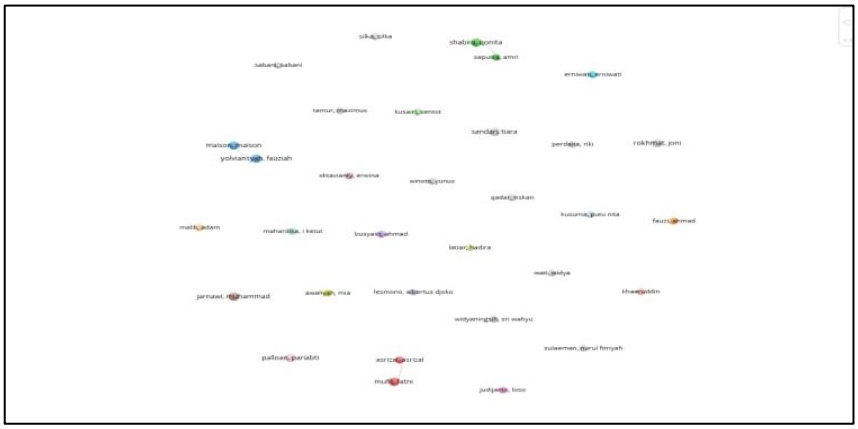


Fig. 7 Network Visualization Co-Authorship at VOSviewer

Table.1 Results of Author Co-authorship Analysis

No	Author	Documets	Total link strength
1.	hasanah,lilik	2	12
2.	irawan,deni	2	12
3.	juhanda,aa	2	12
4.	kustiawan,iwan	2	12
5.	putri,salsabilla,dwita	2	12

6.	rochintaniawati,diana	2	12
7.	susilawati,aay	2	12
8.	hasyim,mutahharah	4	5
9.	admoko,setyo	2	4
10.	haris,abdul	4	4
11.	kafii, Muhammad shokhibul	2	4
12.	martin,William immanuel	2	4
13.	nazidah,fithrotin	2	4
14.	sitompul,stepanus sahala	5	3
15.	mursyid,syukran	2	2
16.	wahyudi,wahyudi	2	2
17.	zuhdi,muhammad	2	2
18.	asrizal,asrizal	32	95
19.	mufti,fatni	24	68
20.	novitra, fuja	15	42
21.	maison,maison	3	1
22.	oktavianty,erwina	2	1
23.	palloan,pariabti	3	1
24.	saputra,amri	2	1
25.	shabira,qonita	3	1
26.	yolviansyah,fauziah	3	1
27.	awaliyah,mia	2	0
28.	busyairi,ahmad	2	0
29.	erniwati,erniwati	2	0
30.	fauzi,ahmad	2	0
31.	jarnawi,muhammad	3	0
32.	judijanto,loso	2	0
33.	khaeruddin	2	0
34.	kusairi,sentot	2	0
35.	kusuma,putu nita	2	0
36.	latiar,hadira	2	0
37.	lesmono,albertus djoko	2	0
38.	mahardika,I ketut	2	0
39.	malik,adam	2	0
40.	perdana,riki	2	0
41.	qadar,riskan	2	0
42.	rokhmat,joni	3	0
43.	sabani,sabani	2	0
44.	sandari,tiara	3	0
45.	silka,silka	2	0
46.	sulaeman,nurul fitriyah	2	0
47.	tamur,maximus	2	0
48.	wati,widya	2	0
49.	widyaningsih,sri wahyu	2	0
50.	winoto,yunus	2	0

Based on the co-authorship analysis of 50 authors, variations were found in the productivity and strength of collaborative relationships among authors in research on physics misconceptions at the high school level in Indonesia. The highest productivity was demonstrated by Asrizal, with 32 documents and a Total Link Strength (TLS) of 95, followed by Mufti/Fatni Mufit, with 24 documents and a TLS of 68, and Novitra/Fuja Novitra, with 15 documents and a TLS of 42. These three authors demonstrated relatively dominant publication contributions compared with the other authors.

The authors with moderate productivity consisted of several researchers who had produced 3–5 documents, while most of the other authors had only 2 documents. This condition indicated that research productivity within the analyzed network had not been evenly distributed. Publications had been more

concentrated among several main authors, whereas other authors had contributed a more limited number of documents.

In terms of collaboration, the Total Link Strength values also indicated differences in the strength of relationships among authors. Several authors with only two documents had a TLS of 12, including Hasanah, Lilik; Irawan, Deni; Juhanda, Aa; Kustiawan, Iwan; Putri, Salsabilla Dwita; Rochintaniawati, Diana; and Susilawati, Aay. This finding indicated that publication productivity did not automatically determine the strength of collaboration. Conversely, authors with fewer documents could have stronger collaborative relationships when their publications involved a larger number of authors within the network.

Meanwhile, several authors had a TLS of 0. This condition indicated that these authors had no co-authorship relationships connected to other authors in the network based on the analyzed data. Thus, the research network on physics misconceptions at the high school level in Indonesia demonstrated groups of authors with strong collaboration, groups with limited collaborative relationships, and authors who were relatively isolated from the main network.

d. Co-Occurrence Analysis: Contribution of the Second Researcher

The co-occurrence analysis of 50 keywords showed that research on physics misconceptions among senior high school students in Indonesia had a relatively broad range of interconnected topics. Based on the Density Visualization, several keywords had higher density, as indicated by the yellow color, particularly keywords related to research, study, data, student, physics, concept, and analysis. This indicated that the research had primarily focused on research studies, students as research subjects, physics concepts, and the processes of data collection and analysis.

The density of these keywords also indicated that research on physics misconceptions had not only focused on identifying students' misconceptions but had also covered conceptual understanding, physics topics, research methods, diagnostic instruments, and learning processes. Keywords located in the green areas showed relatively strong relationships, whereas keywords in the blue areas had relatively lower density and connectivity. The co-occurrence analysis was used to determine the keywords that frequently appeared together in the analyzed documents. In VOSviewer, occurrences indicated the number of times a keyword appeared, links indicated the number of other keywords connected to a particular keyword, while total link strength indicated the overall strength of the keyword's relationships with all other keywords.

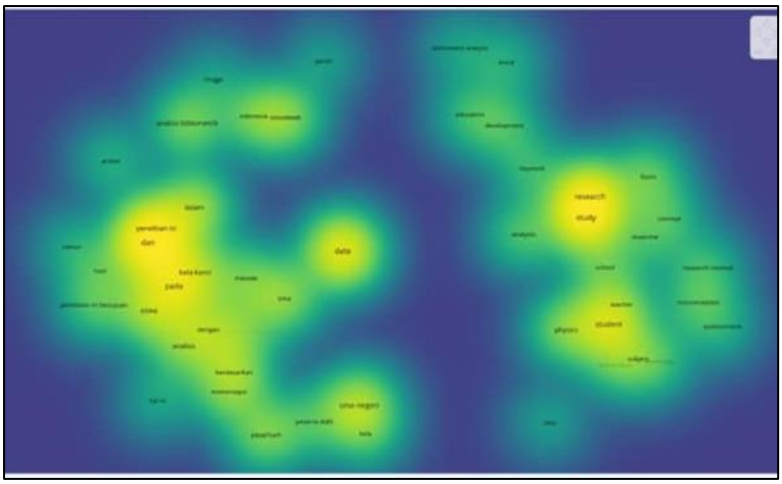


Fig. 8 Analysis of Co-Occurences

Table 12. Results of the Co-Occurrence Analysis

No	Keywords Displayed in Vosviewer	Occurrences	Links	Total Link Strength	Cluster	Focus/Thematic Connections
1.	Bibliometric Analysis	89	49	412	1 (Red)	Bibliometric analysis and research mapping
2.	Indonesia	76	48	358	1 (Red)	Context of the research area
3.	Vosviewer	68	47	295	1(Red)	Bibliometric analysis and visualization tools
4.	Data	54	46	234	1(Red)	Bibliographic research data
5.	Kata kunci	47	45	198	1(Red)	Keyword Frequency Analysis
6.	Metode	42	44	176	1 (Red)	Research Methodology
7.	Siswa	38	43	154	1 (Red)	Topics in Educational Research
8.	SMA	35	42	142	1 (Red)	The educational level that is the focus
9.	Penelitian	32	41	128	1 (Red)	Research Activities and Subjects
10.	Analisis	29	40	115	1 (Red)	The data analysis process
11.	Berdasarkan	27	39	108	1 (Red)	Common terms in research descriptions
12.	Penelitian bertujuan	25	38	98	1 (Red)	The data analysis process
13.	Bibliometric analysis	24	37	92	2 (Green)	Bibliometric analysis and research mapping
14.	Article	23	36	87	2 (Green)	Research Focus or Objective
15.	Education	21	35	79	2 (Green)	Analisis bibliometric
16.	Development	19	34	72	2 (Green)	Development
17.	Keyword	18	33	68	2 (Green)	Research keywords
18.	Research	16	32	61	2 (Green)	Research
19.	Study	15	31	56	2 (Green)	Research Study
20.	Analysis	14	30	52	2 (Green)	Analysis
21.	School	13	29	48	2 (Green)	School
22.	Teacher	12	28	45	2 (Green)	Teacher
23.	Student	11	27	41	2 (Green)	Students
24.	Physics	10	26	38	2 (Green)	Physics
25.	Data analysis	9	25	35	2 (Green)	Data Analysis
26.	Concept	8	24	32	2 (Green)	Concept
27.	Research method	7	23	29	2 (Green)	Research Methodology
28.	Misconception	6	22	26	2 (Green)	Misconceptions
29.	SMA Negeri	5	21	23	1 (Red)	Public high school
30.	Kelas	5	20	21	1 (Red)	Grade levels
31.	Pesertum	5	19	19	1 (Red)	Terms/extracted data
32.	Hasil	5	18	17	1 (Red)	Research findings
33.	Perish	5	17	15	1 (Red)	Publish or Perish
34.	Peserta Didik	5	16	14	1 (Red)	Students
35.	Namun	5	15	13	1(Red)	Common Terms
36.	Dalam	5	14	12	1 (Red)	Common Terms
37.	Form	5	13	11	2 (Green)	Form/instrument
38.	Subject	5	12	10	2 (Green)	Research Subject
39.	Questionnaire	5	11	9	2 (Green)	Questionnaire instrument
40.	Percentage	5	10	8	2 (Green)	Percentage
41.	Data Analysis	5	9	7	2 (Green)	Data analysis

42.	Hal ini	5	8	6	2 (Green)	Common Terms
43.	Until	5	7	5	2 (Green)	Common Terms
44.	Cognitive Conflict	5	6	5	2 (Green)	Cognitive conflict
45.	Diagnostic test	5	5	4	2 (Green)	Diagnostic tests
46.	Conceptual Change	5	4	4	2 (Green)	Conceptual changes
47.	Remeditation	5	3	3	2 (Green)	Remediation
48.	Penelitian ini	5	2	3	2 (Green)	Common terms in the text
49.	Physics learning	5	1	2	2 (Green)	Physics Education
50.	High school	5	1	2	2 (Green)	High school
	Total	898	1226	3492		

Based on the table 12, the total number of links among all keywords was 898. This value indicated that the terms in the documents had a relatively broad range of interconnections. Keywords with high total link strength could be understood as keywords that occupied the most central positions within the network.The most dominant keyword was "Bibliometric Analysis," with 89 occurrences, 49 links, and a total link strength of 412. This keyword represented the main node in the network because it had the highest frequency of occurrence and the strongest connections with other keywords. Subsequently, the keyword "Indonesia" had 76 occurrences, 48 links, and a total link strength of 358. These results confirmed that the analyzed documents largely placed the research within the Indonesian context.

The keyword "VOSviewer" occupied the third position, with 68 occurrences and a total link strength of 295. This indicated that VOSviewer was the most frequently mentioned tool in the documents, particularly for research mapping, network visualization, and analysis of relationships among keywords. In addition, the keywords "data," "keywords," "methods," "students," and "senior high school" also had high frequencies and strong connections. These findings showed that the dataset focused on bibliometric studies in educational research, particularly research involving students at the senior high school level.

IV. CONCLUSION

Based on the results and discussion obtained through analysis using VOSviewer, it was concluded that the mapping and visualization of research on physics misconceptions among senior high school students in Indonesia were examined through co-authorship and keyword co-occurrence analyses. The co-authorship analysis provided an overview of collaboration relationships among authors, whereas the keyword co-occurrence analysis described the relationships among keywords appearing in the publications. The co-authorship analysis showed variations in the number of documents and the strength of relationships among authors. Some authors had relatively high numbers of publications and Total Link Strength (TLS), whereas other authors showed more limited collaborative connections.

This finding indicated that the research network on physics misconceptions among senior high school students was not evenly distributed, as certain authors played more prominent roles within the collaboration network. Meanwhile, the keyword co-occurrence analysis identified 50 items that formed a keyword network consisting of two clusters, 1,226 links, and a Total Link Strength of 3,492. These results indicated relationships among various research topics related to physics misconceptions. Keywords such as *students, physics, concepts, misconceptions, research, methods, data, analysis, schools,* and *instruments* indicated that research on physics misconceptions extended beyond the identification of conceptual errors. The research also covered research participants, specific physics concepts being studied, diagnostic methods, and data analysis processes.

Thus, the VOSviewer visualization provided an overview of the structure of the research network and the relationships among research themes related to physics misconceptions among senior high school students in Indonesia.

1. Based on the results of the Publish or Perish (PoP) mapping of physics misconception research at the senior high school level during the 2020–2025 period, 253 articles were obtained that met the research criteria, and 50 articles were used for the bibliometric analysis. The distribution of articles by publication year showed an increasing trend in the number of studies over the years. In 2020, 25 articles (9.88%) were obtained. Research in this year was relatively focused on the development and use of diagnostic test instruments, such as *Three-Tier Test* and *Four-Tier Test* instruments based on the *Certainty of Response Index* (CRI), to identify misconceptions in fundamental physics topics, including mechanics and electricity. In 2021, 34 articles (13.44%) were obtained. Research during this period developed within the context of learning during the COVID-19 pandemic, particularly in relation to online learning

and the evaluation of senior high school students' conceptual understanding. In 2022, 40 articles (15.81%) were obtained. Research attention was increasingly directed toward efforts to remediate misconceptions through the implementation of various learning models, such as *Cognitive Conflict*, *Predict-Observe-Explain* (POE), and *Discovery Learning*. Furthermore, in 2023, 47 articles (18.58%) were obtained. Research began to focus more on changes in learning and assessment within the context of the Merdeka Curriculum, including the development of diagnostic assessments and more interactive learning instruments. In 2024, 53 articles (20.95%) were obtained.

Physics misconception research was increasingly associated with the development of digital-based instruments or Computer-Based Tests (CBT), as well as the use of digital media and technology in the identification of misconceptions and learning processes. Meanwhile, in 2025, 54 articles (21.34%) were obtained, representing the highest number of publications during the 2020–2025 period. Research during this period was not limited to the identification of misconceptions but also included further studies and *Systematic Literature Reviews* (SLR) concerning identification methods and efforts to reduce misconceptions across various senior high school physics topics. Thus, the distribution of publications during the 2020–2025 period showed an increasing trend in physics misconception research at the senior high school level, both in terms of the number of publications and the diversity of research focuses. This development indicated a shift in research attention from studies primarily oriented toward misconception identification to studies that also addressed remediation, instrument development, digital technology, and the mapping of research findings. Nevertheless, the number of publications in each year was interpreted as a representation based on the data and search criteria used in this study. Variations in the number of articles could also have been influenced by the coverage of the databases, indexing processes, and the article selection criteria applied in the research.

2. Analysis using VOSviewer software identified 50 articles that met the inclusion criteria. The resulting network visualization displays the relationships between keywords; keywords represented by larger circles indicate a higher frequency of occurrence. Keywords positioned close to one another signify stronger relationships, while connecting lines indicate that the keywords appear together in the same articles. The network visualization reveals that the topic of misconceptions regarding atomic concepts forms a research cluster linked to conceptual understanding, diagnostic tests, atomic structure, the atomic nucleus, and radioactive decay. These keyword relationships demonstrate that research into atomic concept misconceptions focuses not only on students' misunderstandings regarding atomic structure and components but also encompasses the use of diagnostic instruments to identify specific forms of misconceptions with greater accuracy.
3. Based on a co-occurrence analysis of keywords mapping the main topics of research into physics misconceptions, the total number of links among all keywords is 898. This figure indicates a relatively broad scope of interconnectedness among the terms found in the documents. Keywords with high total link strength can be understood as occupying the most central positions within the network. The most dominant keyword is "Bibliometric Analysis," with 89 occurrences, 49 links, and a total link strength of 412. This keyword represents a key node in the network, as it possesses the highest frequency of occurrence and the strongest connections to other keywords. Next, the keyword "Indonesia" shows 76 occurrences, 48 links, and a total link strength of 358; these results confirm that the majority of the analyzed documents situate the research within the Indonesian context. The keyword "VOSviewer" ranks third, with 68 occurrences and a total link strength of 295. This indicates that VOSviewer is the tool most frequently cited in the documents, particularly for research mapping, network visualization, and the analysis of keyword relationships. Additionally, keywords such as "data," "keywords," "methods," "students," and "senior high school" also exhibit high frequencies and strong connections. These findings demonstrate that the dataset focuses on bibliometric studies within educational research, specifically research involving students at the senior high school level.

ACKNOWLEDGMENT

The authors would like to express their sincere gratitude to their advisors and faculty members for their valuable guidance, constructive suggestions, and unwavering support throughout the research process. The authors would also like to thank everyone who provided moral support, encouragement, and assistance, enabling this research to be successfully completed.

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