

## Online discussion in improving argumentation skills during last decade: A review

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### ABSTRACT

This study aimed to find research trend online discussion to improve argumentation skills in education especially physics education. The method used in this research is bibliometric analysis by using VOSviewer. The data used is the Scopus database in the last 10 years. The research findings found that there are 1,447 documents that meet the predetermined criteria. The number of online discussion research increases gradually over the research period 2012-2021. The two highest sources of documents came from journals and conference proceedings and a higher percentage of citations were carried out on scientific journal. There are five trend research clusters on online discussion (4 main clusters and 1 secondary). The first cluster focuses on online discussion methods, the second cluster focuses on online discussion model, the third cluster focuses on the application of online discussions, the fourth cluster focuses on media used in online discussions, the fifth secondary cluster focuses on the goals of online discussion. The "argumentation" keyword is not included in the top 10 keywords, this shows that online discussion research has just little linked to argumentation as an indicator of the quality of online discussion. This condition creates an opportunity for further research related to online discussion in improving argumentation skills.

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## 1. INTRODUCTION

The COVID-19 pandemic has changed the learning system [1]–[3]. Learning that was initially carried out face-to-face was replaced with distance learning or online [4], [5]. No exception in learning physics. The existence of this makes the learning carried out less than optimal. One of them is about interaction and communication in the online learning process [6], [7]. Communication has the meaning of a process of sending messages or information from the communicator (the person who sends the message) to the communicant (the person who receives the message) [8], [9]. Communication is one of the important things in physics learning [10], [11]. Communication is useful for explaining physics concept [12] and solving problems constructively [13]. In addition, communication is one of the goals of 21st century learning that is important to develop [14].

The communication process in the learning process can be done using the discussion method [15]–[17]. The method of discussion can be done face-to-face or online. Online discussion can be interpreted as a text-based learning activity where learning is not limited by place and time which aims to interact with each

other in discussing certain topics [18], explains that group discussion is a thought process through reasoning that can develop argumentation skills. In order to keep argumentation skills achieved, learning can be done by means of online discussions. This is supported because online discussion has been widely applied in the university context as an important part of the learning process [19]–[21]. The use of online discussion forums tends to lead students to better achievement [22]. In addition, activities with online discussion forums can improve student learning skills and the relationship between them because of the collaborative nature. In addition, in physics learning, online learning is positively correlated with learning achievement which can be seen from the ability to communicate and self-regulate [2]. Meanwhile, quality online discussions will be able to improve students conceptual understanding and argumentation skills as a key in science learning [23].

The importance of argumentation-based learning in science education has been recognized by stakeholders in the field of education in various countries [24], this is marked by: i) The increasing number of scientific argumentation research globally; ii) The trend of scientific argumentation research which moves from theoretical research to practical research to teach science argumentation skills to students; and iii) In the past two decades the teaching and learning of argumentation has emerged in education curricula in various countries as a significant educational goal, including in Indonesia [25]. Meanwhile, in the global evaluation of the Program for International Student Assessment's (PISA) argument-based questions, Indonesia's position has been in the bottom 5 for the last three period [26]–[28]. Based on this background, it is very important to research how online discussion trends in developing students' argumentation skills.

Previous review research on online discussion has conducted about student contribution in asynchronous online discussion [17], effectiveness of online discussion strategies [22], alternative discussion environments that highly needed to offer better support for asynchronous online communication [29], online discussions in online higher education [30] and developing students' critical thinking through online discussion [31]. However, there is no research related to bibliometric analysis in online discussions that relates it to argumentation skills. Bibliometric is a method of analyzing large amounts of data to determine the state of the intellectual structure and trends in emerging research fields [32]. In addition, bibliometrics can also provide a mapping visualization regarding the scope of the field being studied. Considering the importance of argumentation skills in education, this study generally aims to obtain an overview of online discussion research trends in relation to improving argumentation skills. The specific aims of this study are i) Analyzing types of documents, and year-wise distribution on the application of the online discussion for the last 10 years; ii) Analyzing Source title, subject area, and keywords in the application of online discussion for the last 10 years; iii) Analyzing authorship, cited article, institution in the application of online discussion methods for the last 10 years; iv) Analyzing productive countries that have contributed to the application of online discussion for the last 10 years; v) Analyzing the results of trend visualization in the application of online discussion in improving argumentation skills for the last 10 years; and vi) Reviewing several related articles in the application of online discussion methods in physics learning.

## 2. RESEARCH METHOD

This research is a type of literature study using the bibliometric method. In the future, this bibliometric analysis is expected to become a valuable reference [33]–[35]. Therefore, it is important to carry out bibliometric research to get a broader perspective and how the level of relevance of content is related to bibliometric analysis [36]. The approach used in this study is a qualitative approach [22], [37]–[40]. The data used in this study are in the range of 2012-2021 which is secondary data from the Scopus database which was accessed on May, 2022. The number of documents obtained was 1447 documents. Scopus database that has been obtained, then save in the form of (.Ris) until further analysis. The stage of visualizing data to become tables, graphs, and maps using Microsoft Excel and VOSviewer application [41]–[43]. Figure 1 shows the bibliometric research flow chart [44].

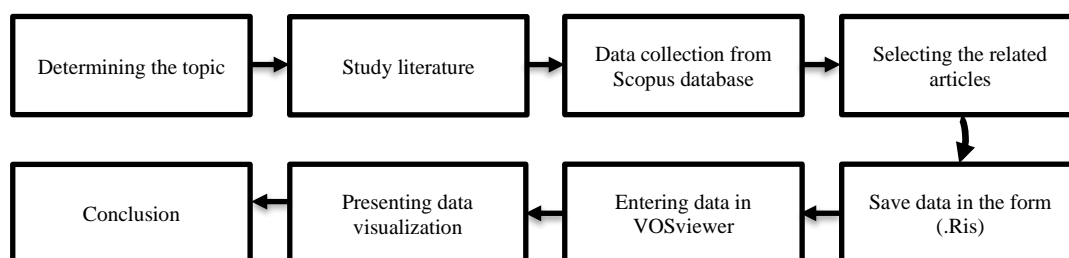


Figure 1. Research flowchart

### 3. RESULTS AND DISCUSSION

#### 3.1. Year-wise distribution and document type

The distribution of publications regarding online discussions in the last 10 years is can be seen in Figure 2. In those 10 years, every year there is no significant increase in the number of publications produced. This can be seen from the number of publications produced which increases and decreases in certain years. The most publications were in 2020 (187 publications) and the least in 2012 (100 publications). Meanwhile, the distribution of the top 100 articles in the last 10 years is different from Figure 2. As displayed in Figure 3, the distribution of the top 100 articles from 2012-2020 tends to experience a significant decline. The decrease in the number of publications each year is due to the existence of the year affecting the number of citations obtained. Thus, the longer the publication time, the greater the number of citations to reach the top 100 citations. In addition, the top citation of articles throughout the year is also influenced by the quality of the authors [23]. The highest number of publication distributions occurred in 2012 (20 publications) and the least in 2021 (0 publications).

There are several types of published documents between 2012-2021 as shown in Figure 4. A total of 1,447 documents that existed for 10 years consisted of 10 types of documents. From the figure, it can be seen that 59.9% were dominated by articles, then conference papers (29.7%), book chapters (5.3%), and other types of documents (5.1%). In the top 100 articles in Figure 5, there are fewer types of documents compared to Figure 4, which are five types of documents. Similar to Figure 4 where the types of documents are dominated by articles (82%), then conference papers (12%), and other documents (6%). So, from Figure 4 and Figure 5, it can be concluded that articles and conference papers are the dominant types of documents used. This is in accordance with research [36] that articles dominate the number of existing publications.

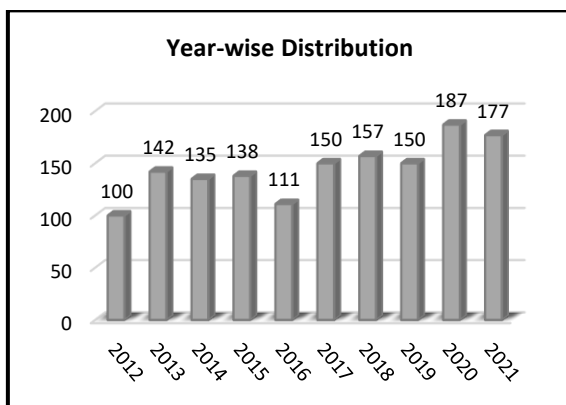


Figure 2. Year wise distribution graph on online discussion

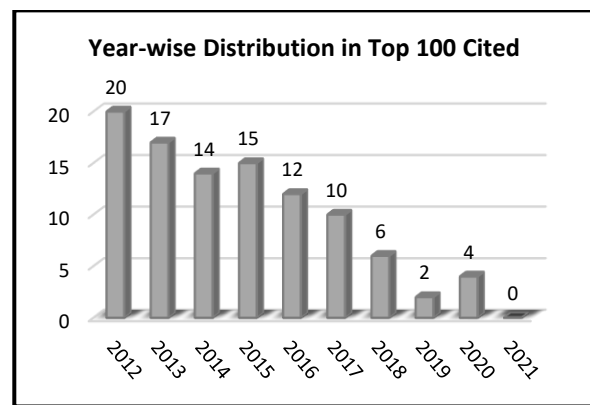


Figure 3. Year-wise distribution graph on top 100 cited online discussion

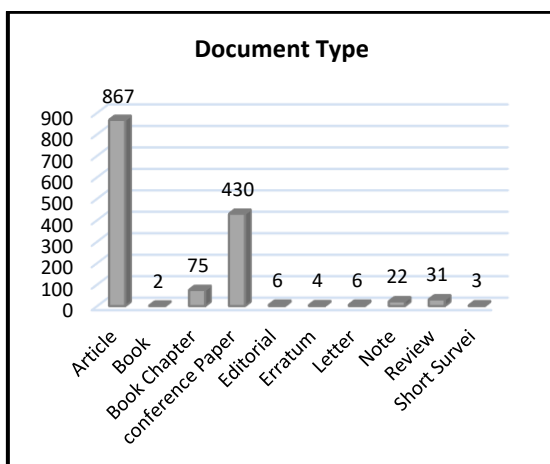


Figure 4. Document type graph on online discussion

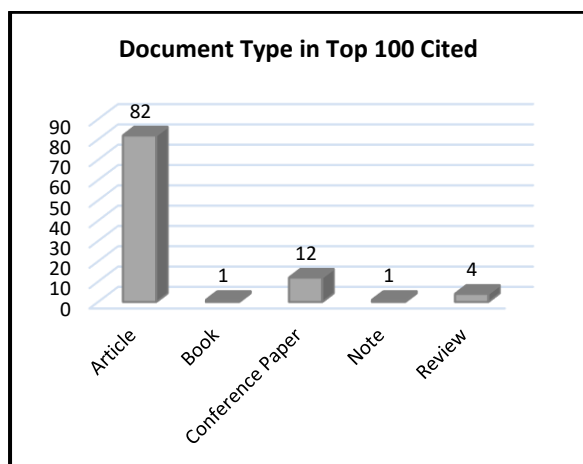


Figure 5. Document type graph on top 100 cited online discussion

### 3.2. Source title, subject area, and keywords

Table 1 shows the top 10 source title online discussions in the 2012-2021 timeframe. The source title that contributed the most to online discussion research was Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Biofarma with 36 documents. Meanwhile, the subject area shown in Table 2 is dominated by social sciences (848). Table 3 shows the keywords used in the last 10 years, social networking being the most widely used keyword, with 416. The keyword physics learning, or argumentation is not included in the top 10 keywords, so it can be used as an opportunity to conduct research on online discussion in physics learning to improve students' argumentation skills.

Table.1 Top 10 source titles of online discussion in the last 10 years

No	Source title	Total
1	Lecture Notes in Computer Science Including Subseries Lecture Notes in Artificial Intelligence and Lecture Notes in Biofarma	36
2	ACM International Conference Proceeding Series	33
3	Computers And Education	27
4	Ceur Workshop Proceedings	16
5	Computer and Human Behavior	16
6	Computer Supported Collaborative Learning Conference	15
7	Proceedings of Annual Hawaii International Conferences on System Sciences	15
8	Online Learning Journal	14
9	British Journal of Educational Technology	12
10	ASEE Annual Conference and Exposition Conference Proceedings	10

Table 2. Top 10 subject area of online discussion

No	Subject area	Total
1	Social Sciences	848
2	Computer Science	655
3	Medicine	163
4	Art and Humanities	160
5	Engineering	132
6	Psychology	93
7	Mathematics	77
8	Business, Management, and Accounting	49
9	Decision Sciences	47
10	Nursing	38

Table 3. Top 10 keyword of online discussion

No	Keyword	Total
1	Social networking (Online)	416
2	Online discussion	343
3	Human	220
4	Student	193
5	E-learning	180
6	Humans	178
7	Online discussion	153
8	Internet	128
9	Article	124
10	Social media	120

### 3.3. Author, cited article, and institution

Table 4 shows the authors who contributed to online discussion research over the last 10 years. In online discussions, the author who has contributed the most to online discussions in the last 10 years is Wise, with 15 documents. The other top 10 authors in full are Hou, Kim, Wu, Gasevic, Ito, Olfman, Chiu, Gasevic, and Rolim as presented in Table 4.

Table 5 shows the top 10 cited articles [45]–[54], articles written by Alessandro Bessi and Emilio Ferara received 397 citations. While at the institution, Simon Fraser University had the most documents with 25. Then followed by the University of Southern California (19), Monash University (18), Huazhong Normal University (16) and others as presented in Table 6. In the data, the contribution of Indonesian institutions to online discussion research both in general and in physics learning is still very low. Thus, it provides a great opportunity to conduct this research topic.

Table 4. Top 10 productive authors graph of online discussion during 2012-2021

No.	Author	Total
1	Wise	15
2	Hou	14
3	Kim	11
4	Wu	11
5	Gasevic	8
6	Ito	8
7	Olfman	8
8	Chiu	7
9	Gasevic	7
10	Rolim	7

Table 5. Top 10 articles of online discussion in the last 10 years

No	Ref.	Cited	Findings	Recommendations
1	[45]	397	The results obtained are that the existence of these bots affects the process of the 2016 US presidential election. From these results it is found that most bot users may be humans as much as one-fifth of the total. In addition, the presence of social media bots can also have a negative impact on political discussion and can potentially change public opinion and adversely affect the integrity of the presidential election.	Long period of time. Although in this study bot behavior developed within 1 month, it would be better if the research was carried out longer. In addition, the research subject is not only a debate about politics but can also be developed in the educational aspect. Regarding bots, there needs to be development so that the data obtained becomes more accurate.
2	[46]	209	This research was conducted using a longitudinal analysis of online discussions using a predictive model. This study can analyze a person's trolling behavior. The results obtained, trolling behavior both together and individually can be influenced by the mood and context of the discussion.	Differentiating different types of users which will eventually lead to trolling. The point is, it can be distinguished whether the trolling is innate, or only appears at certain times. In addition, it is also necessary to develop tools that can detect trolling behavior appropriately and can support the research.
3	[47]	173	The comment rate on the Washington Post website is worse and disrespectful than the comments on the Washington DC Facebook. This can be caused by the use of profiles. The Washington Post website does not contain a profile of a person who left a comment, so they are free to post any comments. Unlike the Facebook Washington Post where each comment has a profile for each account so that the writing of impolite comments is less.	This research can be developed by comparing 3 or more different social media platforms such as Instagram, Twitter, and Line. That way, more comparisons can be obtained regarding the level of politeness of social media users and online discussions on social media.
4	[48]	166	A lot of fake news is circulating in the community, both political issues and others. The existence of this fake news can have a negative impact on social media users.	Suggestions for further research are 1) provide solutions or countermeasures to avoid fake news, 2) develop fake news detection methods so that they are more sophisticated and can detect precisely and accurately, 3) provide a comparison of the number of fake news circulating on each social media.
5	[49]	157	Persuasion arguments can be detected by interesting interaction patterns such as entry-order and exchange rate back and forth which then compares similar counterarguments with the same opinion. This study also shows that the factors that play an important role are language and expression when carrying out the persuasive argument.	Suggestions for further researchers are 1) to develop detection of interaction patterns related to persuasion arguments, 2) to expand the factors that influence persuasion arguments.
6	[50]	155	The results of this study found that online communication has a significant influence on citizen involvement in politics. Meanwhile, offline participation is more focused on the use of news, political orientation, and sociodemographic. Of the two ways of discussing, online discussion has a positive impact on online participation. This is due to the consistency of the participation argument.	It can be carried out in different areas of discussion, for example regarding education, socio-culture, and economics. In addition, the use of online media can also be more diverse.
7	[51]	154	This study discusses the influence of news on the level of participation and interactivity. In addition, this study also discusses the theoretical, normative, and practical implications of the findings obtained. The results of this study indicate that online news can affect the interaction and activeness of participation.	There are several suggestions for further research, namely 1) increasing the research time in a longer period of time, 2) adding different types of online newspapers so that the discussion of news becomes wider.
8	[52]	145	This study discusses three characteristics of antisocial behavior in online discussion communities, namely 1) users tend to focus, post, and respond to other users, 2) users become less tolerant in society when they are blocked from the community, 3) community feedback that is too harsh makes antisocial behavior worse.	For further research, it can focus on how to overcome antisocial behavior. In addition, it can be used as a comparison of antisocial properties through online discussions with face-to-face discussions.
9	[53]	136	This study discusses the effect of social support on the experience of childbearing to girls in order to prevent postpartum depression. The results obtained are that social support groups have a positive influence on postpartum women's emotions. This is because the group provides information, encouragement, and hope for women who experience postpartum depression.	Suggestions for further research is to investigate what if the woman childbearing to a boy, as well as expand the reach of the online support groups to be researched.
10	[54]	115	The results obtained are that there is a positive relationship when teaching by linking social attendance with academic performance. This is indicated by the increased interaction between students which becomes more meaningful. In addition, early detection of student failure in the course can be known through social attendance indicators.	Focusing on online learning models to assess their implementation. Research in a larger scope is urgently needed in teaching and learning research.

Table 6. Top 10 institution of online discussion in the last 10 years

No	Institution	Total
1	Simon Fraser University	25
2	University of Southern California	19
3	Monash University	18
4	Huazhong Normal University	16
5	Arizona State University	15
6	National Central University	15
7	National Taiwan University of Science and Technology	15
8	Tampere University	14
9	Information Sciences Institute	14
10	University of Georgia	14

**3.4. Productive countries**

Analysis of productive countries was based on the number of papers produced by countries in 100 top citations. The first position was occupied by the United States with 48 documents, followed by Canada with 12 documents, United Kingdom with 9 documents, Taiwan with 5 documents, Australia with 4 documents, Germany with 3 documents, China, Hong Kong, and Israel with 2 documents. The ranking order of productive countries is an indicator that shows the level of research development in the field of online discussion in a country.

**3.5. Visualization of online trend discussion**

Figure 6 shows the results of the author’s visualization over the last 10 years using VOSviewer. There are seven authors who contributed greatly to online discussion research, namely Wise, Kim, Chen, Olfman, Gašević, Hou, and Lee. Based on the visualization of VOSviewer, there are several research collaborations groups, but collaboration between groups only occurs in certain parts.

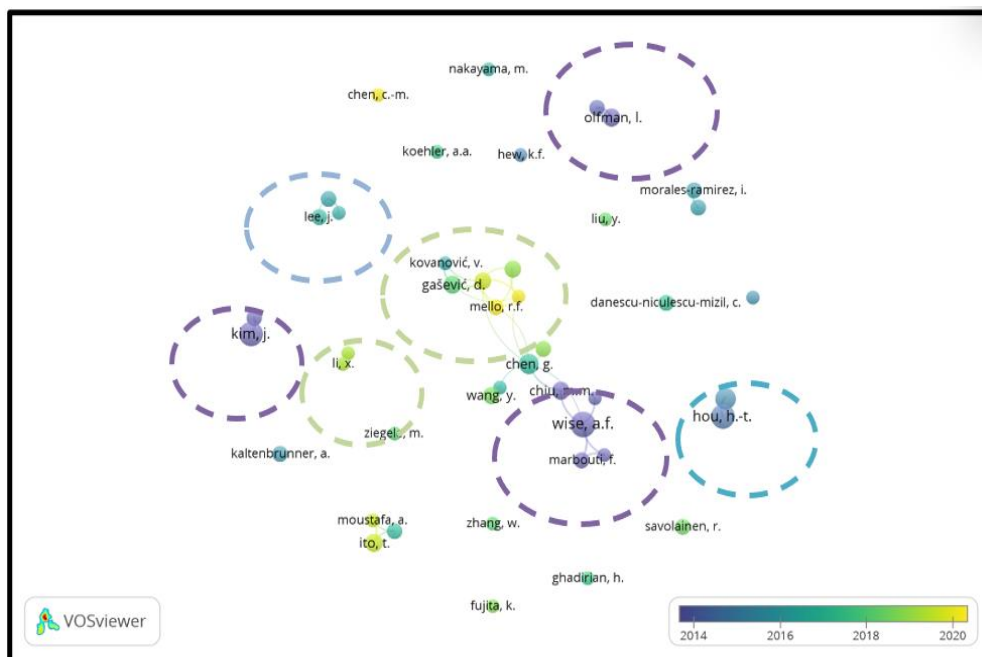


Figure 6. Visualization author online discussion during 2012-2021

In visualization, there are 461 relevant keywords. Based on Table 7, the most keywords are human with occurrence 220 and total link strength 2761, then in second place is social networking (online) with occurrences 416 and total link strength 2743. Then, it was followed by online discussion as many as 343 and 1939; articles as many as 124 and 1689; internet 128 and 1594; students with 193 and 1514; e-learning with 182 and 1328; education with 90 and 1052; social media with 120 and 998.

Table 7. Keyword, occurrences, total link strength of online discussion in the last 10 years

Keyword	Occurrences	Total link strength
Human	220	2761
Social Networking (Online)	416	2743
Online Discussion	343	1939
Article	124	1689
Internet	128	1594
Student	193	1514
E-learning	182	1328
Education	90	1052
Social Media	120	998
Psychology	61	955

Figure 7 shows the results of trend visualization online discussion in the last ten years. The results obtained are that there are five clusters (4 main clusters and 1 secondary) in the image. Colors and circles that are getting clearer and bigger indicate that there are more links between one keyword and another [55]. The first red cluster with 27 items, this cluster focuses on online discussion methods such as argumentation, asynchronous discussion, collaborative learning, communities of practice, critical thinking, discussion, and others. This is in accordance with [56]–[58] which explain that there is a link between online discussion and argumentation skills. The visualization results show that there is a relationship between online discussion and critical thinking. This is in accordance with research [59] which shows that the use of online learning can improve students critical thinking skill and the quality of online discussions can be evaluated by critical thinking criteria [60]. The second green cluster (24 items) focuses on online discussion model subjects such as human, student, internet, and others. The third blue cluster (18 items) focuses on the application of online discussions such as artificial intelligence, discussion threads, learning systems, social networking (online), and others. The fourth cluster is yellow (12 items) which focuses on media used in online discussions such as mobile devices, e-learning, and online teaching. The use of e-learning in the form of virtual laboratories can be used as an alternative to improve students experience and scientific argumentation skill [61], [62]. In addition, the use of technology for virtual learning also has an impact on online learning [63]. The fifth cluster is purple (9 items) which focuses on the goals of online discussion such as problem solving, collaboration, online support, and others.

Meanwhile, Gao, Zhang, and Franklin [29] with a different method found four topics of future research trends in asynchronous online discussions, namely i) Exploring new environments that support varied goals of learning; ii) Integrating emerging technologies to address the constraints of current environments; iii) Designing multifunctional environments to facilitate complex learning; and iv) Developing appropriate instructional activities and strategies for these environments. If we compare the findings of the five trend topics of this research with the four trend topics of research by Gao, it appears that in general they both have the same trend but differ in the use of the terms. The small difference is that Gao places more emphasis on a learning environment that supports learning goals and complex learning activities in online discussions.

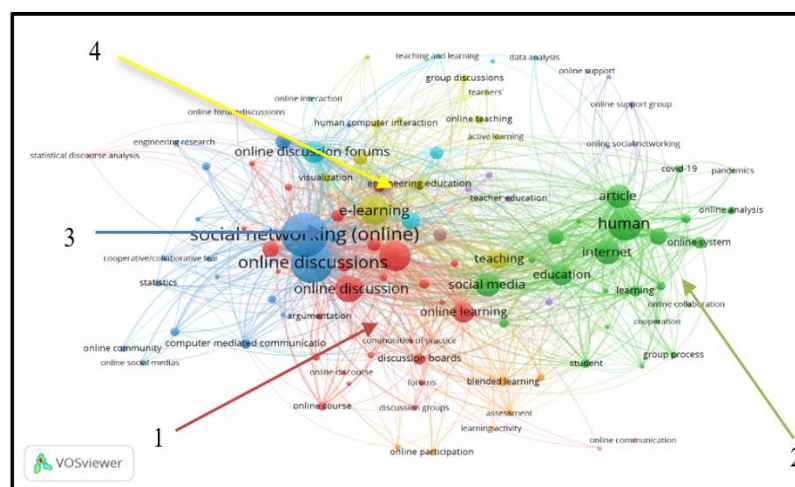


Figure 7. Visualization of online discussion

Figure 8 shows the visualization relation variable, Figure 8 (a) shows specifically the relationship between keywords. It can be seen that online discussion is related to e-learning, student, argumentation, communication, internet, and others. Figure 8 (b) shows the visualization of e-learning keywords. E-learning keywords focus on education, teaching, online learning, human, and internet. Figure 8 (c) shows the results of visualizing the keyword education. These keywords focus on active learning, discussion, social media, blended learning, and others. Figure 8 (d) shows the keyword communication focuses on interactivity, discussion boards, distance education, and social networks. Lastly, the visualization of argumentation keywords is shown in Figure 9. Argumentation is related to problem solving, online discussion, social networking (online), visualization, scaffolding and others. This is in line with previous research, that the use of argumentation-based interactive web in online discussion classes can significantly improve reasoning ability [33], argumentation skills are also needed in online discussions and debates [34].

Based on Figure 9, it is known that online discussion is more related to online learning or distance learning. However, there are only few “argumentation” keywords related to “online discussions”. The “argumentation” keywords related to other keywords like “online deliberation”, “interactivity”, “visualization”, and “problem solving”. From this relationship, argumentation skills are the key in problem solving. Where problem solving is carried out through online discussions, it requires the active interaction of all group members involved. This is in line with what Iordanou said that argumentation skills are very well developed in learning that applies the context of science to social life or socio-science issues [64]. Meanwhile, argumentation and collaborative discourse are frequently thought to promote conceptual understanding and deeper learning of content and make learning gains more permanent [65]. From the discussion, it can be seen how important argumentation is in education. However, the “argumentation” keyword is not included in the top 10 keywords, this shows that online discussion research has just little linked to argumentation as an indicator of the quality of online discussion. This creates an opportunity for further research related to online discussion in improving argumentation skills.

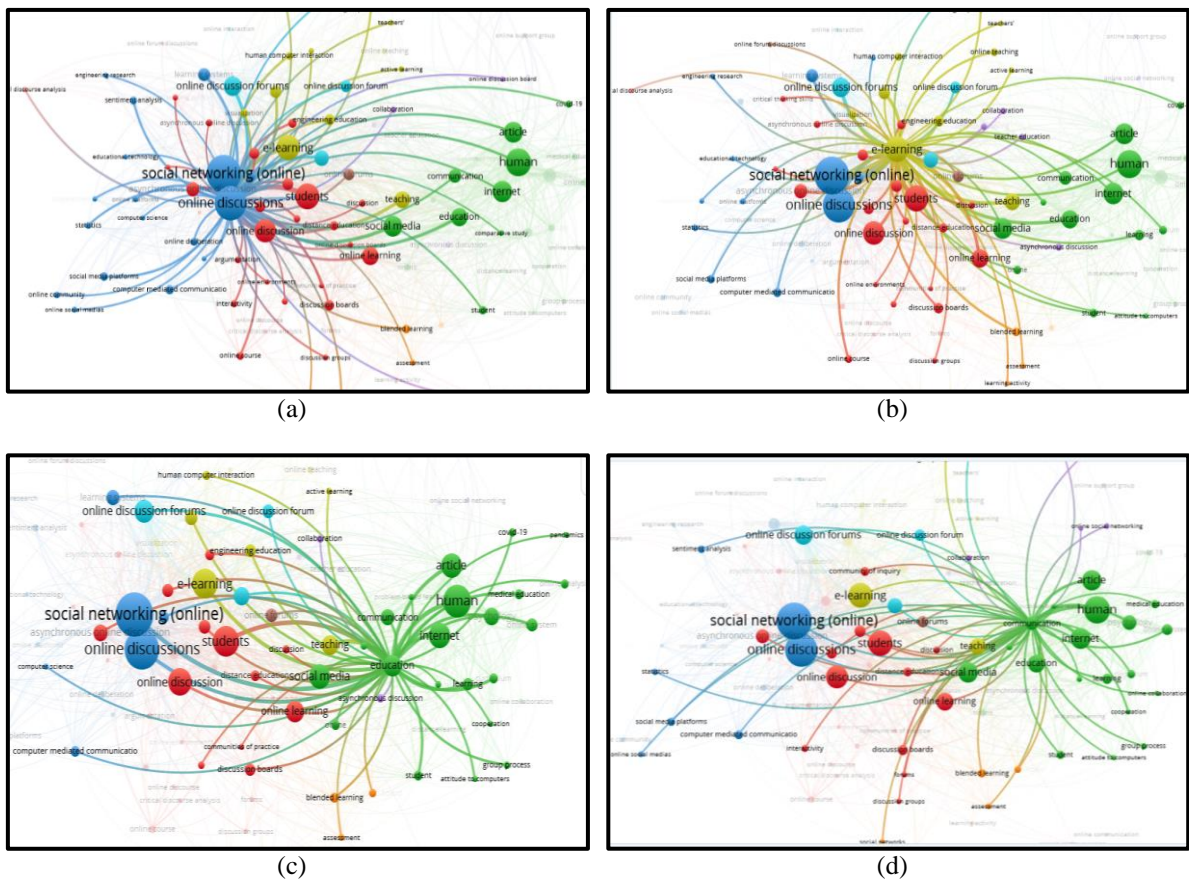


Figure 8. Visualization relation variable of (a) online discussion, (b) e-learning, (c) education, and (d) communication



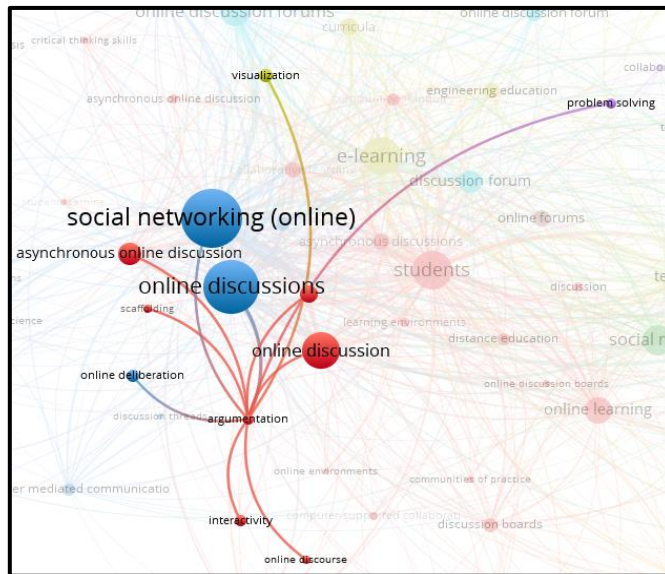


Figure 9. Visualization of argumentation

### 3.6. Review of the top 5 online discussion article in physics learning

The review was conducted based subject related with the author department (physics education) on the top 5 publications cited as impactful studies on online discussion research during the last ten years. Each article was analyzed based on the findings and recommend in the article. Table 8 show the result review top 5 articles on online discussion in physics learning.

Table 8. Review top 5 articles on online discussion in physics learning

Ref.	Cited	Findings	Recommendations
[66]	34	This study shows that students engage in high-level online discussions and will provide answers to each question. This will increase the understanding of the concept. On the other hand, students with low levels of online discussion can be seen from the lack of answering questions from their friends.	The period of time used in research can be extended so that the increase in understanding of concepts can be more visible, in addition, the number of students can be increased so that the data obtained is more accurate. The material in the research can be developed using other physics courses.
[67]	22	This research compares traditional (face-to-face) learning methods with online physics learning. It was found that students who participated in online learning more often opened material than students with traditional learning methods. In addition, students who participate in online learning more often contribute and express opinions during class. So, it can be concluded that online learning provides better benefits than traditional learning.	This research can be developed by using learning media that can support student discussion activities. In addition, this research can also be developed by applying a certain learning model.
[68]	7	This research introduces a website, namely VIA (Virtual Institute of Astroparticle as a new platform for discussing physics. The website shows that this website can support participation in a conference or meeting. In addition, this website can reach all over the world thereby increasing the number of participation of participants with questions about physics without being limited by time and place	This platform supports a particular conference or community in physics discovery that discusses astroparticle physics. Suggestions for further research is to develop a platform to discuss physics, especially for students. Topics or materials that can be discussed can also be more diverse.
[69]	5	This study concludes that interactions in the e-learning process learning is low. This is evidenced by the percentage of interaction between students by 14%, interaction between student-material by 38%, and interaction between students and teachers by 25%.	Further research can be developed using certain learning methods that can lead to good interactions between students and teachers. The number of samples used needs to be increased as well as the need for the use of learning media.
[70]	3	This study develops a platform to measure the emotional level of students when learning takes place for 1 semester. The results obtained indicate that there is no significant change to the emotional level of students. This allows for real-time monitoring of emotional levels in the classroom.	Further research can be done by combining several platforms so that we can find out the comparison of each platform used. In addition, the addition of text is also needed to add insight and discussion activities.

#### 4. CONCLUSION

The result of the study found that the number of online discussion research increases gradually over the research period 2012–2021. The top 10 keywords used were human, social networking, online discussion, article, internet, student, e-learning, education, social media and psychology. The “argumentation” keyword is not included in the top 10 keywords, this shows that online discussion research has not linked argumentation as an indicator of the quality of online discussion. This creates an opportunity for further research related to online discussion in improving argumentation skills. There are five trend research clusters on online discussion (4 main clusters and 1 secondary). The first cluster focuses on online discussion methods such as argumentation, asynchronous discussion, collaborative learning, communities of practice, critical thinking, discussion, and others. The second cluster focuses on online discussion model subjects such as human, student, internet, and others. The third cluster focuses on the application of online discussions such as artificial intelligence, discussion threads, learning systems, social networking (online), and others. The fourth cluster focuses on media used in online discussions such as mobile devices, e-learning, online teaching, and others. The fifth secondary cluster focuses on the goals of online discussion such as problem solving, collaboration, online support, and others. The results of the review of the top 5 articles related to online discussions in physics learning discuss learning progress, comparisons different type of online discussions, and the use of media in the online discussion process in physics learning.

The results will be useful for further researchers who will conduct research related to online discussions as a basis for knowledge and initial perspectives. Based on the findings of online discussion research trends, online discussions in learning are more likely to be associated with social aspects of learning in general but have not focused on the quality of good online discussions. Research that focuses on the quality of online discussions will tend to reveal variables related to critical thinking, argumentation, and fact-based claim verification. This finding brings an opportunity to conduct further research on how to carry out quality online discussion learning based on critical thinking skills and argumentation skills.

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