Bibliometric Analysis: Scopus Indexed Formative Assessment Learning Research Trends in the Last Decade

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Abstract. The application of 21st century learning cannot but be followed by appropriate evaluation in the 21st century. Education has a reciprocal relationship and a strong influence on what and how it is taught. Teachers can carry out assessments, namely by using formative assessments. This research aims to map research that has been conducted throughout the world regarding formative assessment over the last 10 years. The method used is bibliometric analysis with data analysis using the R studio biblioshiny package. The results obtained are in the form of Scopus data for 1570 articles and show that the research trend has increased significantly in 2016-2021. There are 4 clusters with 18 keywords. The most productive author is Parno p and there are 11 countries that actively publish on formative assessment themes, the top being the United States. This research shows the global significance of formative assessment as a measuring tool in the world of education in providing an overview and improvement of education in the future.

Keywords: Asessment Formative, Bhibliometric, scopus

1 Introduction

The 21st century education demands the creation of quality students. The learning process carried out by teachers to improve students' intellectual, moral and various abilities, including thinking skills, creativity levels, knowledge construction levels, problem solving levels, and skills in understanding learning material well, is one of the abilities that needs to be developed in the next century [1]. The implementation of 21st century learning cannot fail to be followed by appropriate evaluation in the 21st century. The vision of 21st century assessment means that assessment does not only measure knowledge in the form of discrete facts, but also includes the ability to apply knowledge in a complex manner to all situations [2].

RI Minister of Education and Culture Regulation No. 103 of 2014 states that there are important points that must be included in the learning implementation plan (RPP), namely assessment. Education is related to assessment and evaluation. This is in accordance with what is said [3] that assessment and education have a reciprocal relationship and a strong effect on what and how is taught. In this case, teachers must prepare techniques and mechanisms for implementing comprehensive assessments and measurements, and are also required to coordinate with other teachers, if the teaching material comes from different teachers. Teachers can carry out assessments, by using formative assessments.

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Formative assessment as a process used by teachers and students to recognize and respond to student learning to improve the learning and learning process. Formative assessments help teachers describe student learning progress and inform decisions about next steps in learning [4]. So formative assessment information can be used by teachers and students to modify their learning or teaching methods in the hope of getting more effective results. The characteristics of formative assessment are as follows: 1) carried out at the end of each lesson unit, 2) aims to find out to what extent the learning objectives in each lesson unit have been achieved, 3) functions to provide feedback to improve the teaching and learning process, 4) carried out with using learning outcomes tests, questionnaires or other appropriate methods, 5) students are considered successful if they reach a mastery level of at least 70% of the learning objectives to be achieved [5]. Based on the learning objectives, it shows that formative assessment has a very important role in helping teachers to provide an overview of students' abilities so that teachers and students can modify learning methods to achieve effective results.

Research related to formative assessment includes research [6] which was conducted by developing a literacy-based formative assessment instrument in the context of global warming material. The results of this research indicate that the formative assessment instrument they developed is suitable for describing the profile of scientific literacy and critical thinking abilities of high school students. Apart from that, [7] also conducted research related to formative assessment during the Covid-19 pandemic by using self-assessment to obtain feedback. This self-assessment is carried out online to assess the extent to which the learning objectives have been achieved. Apart from that, research results related to formative assessment have been widely carried out in the world and cover various other aspects of learning.

Referring to this research, it illustrates that formative research can describe students' abilities, so it is important to continue to study it. This manuscript aims to carry out an in-depth bibliometric analysis of research trends regarding formative research. Bibliometric analysis makes it easier for researchers to study the bibliographic content and citations of each article [9]. The focus of this research is identifying themes related to formative assessment, analyzing how the research focus has developed over time, and identifying collaborative networks between researchers and institutions that contribute to formative assessment research. This research can make an important contribution to education and research stakeholders in understanding the development of research so far, providing educators with an idea that the application of formative assessment has been implemented throughout the world of education and highlighting collaboration that can be improved.

2 Method

This research uses bibliometric analysis in the data analysis process. Bibliometrics is the application of mathematical and statistical methods used to analyze and assess scientific publications that allow us to identify research trends in [10]. By using bibliometric analysis, you can find and prove the latest research trends that are developing. The data used in this research comes from Scopus with a period of 2013-2023. The data collected was in the form of 5125 articles and conference papers.

Then filtered using only 2 Scopus database keywords, namely "Formative Assessment" and "Learning". So, 1570 databases were obtained, then the filtered data was analyzed using Vos viewer and R studio software.

3 Results and Discussion

3.1 Results

Publication Trends. The development of publications regarding formative assessment in the 2013 to 2023 period experienced an increase in 2016 to 2021. A total of 1570 documents were successfully identified and included in the bibliometric analysis. Following are the search results for the last 10 years.

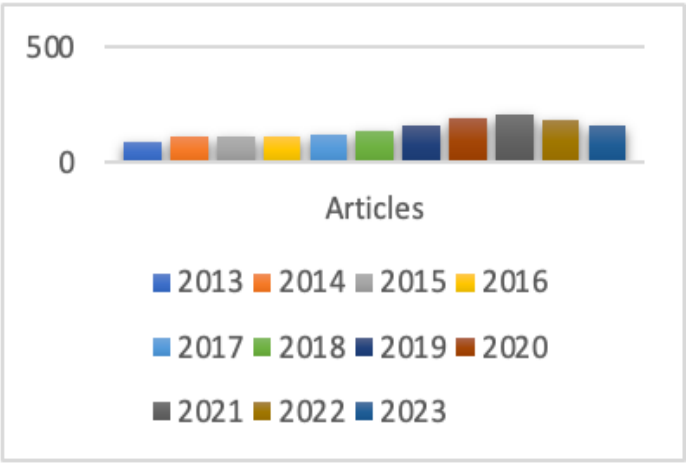

Fig. 1. Annual Scientific Production

Figure 2 shows the number of document publications in the field of formative assessment of Science Education from 2015 to 2021 with an increase in documents published in the Scopus database. However, in 2022 there will be a decrease in the number of documents from the previous year, namely 203 to 185. This could occur due to the impact of Covid-19 which has implications for the number of publications. In 2023, the number of publications will decrease again, namely 30 publications. This could be because it is still ongoing, meaning the number of publications has not yet reached one year.

Publications for Country. There are 87 countries that publish publications related to the theme "Formative Assessment". In the last 10 years, there are 11 top countries that are actively discussing this theme with an average publication above 50. The following are the search results for the last 10 years which are explained in the table.

Table 1. Top 11 countries and number of documents

No	Country	Papers
1	Usa	632
2	Spain	220
3	Australia	184
4	Uk	168
5	China	152
6	Indonesia	145
7	Netherlands	116
8	Germany	113
9	Canada	68
10	Italy	57
11	Malaysia	55

Based on Table 1. 11 countries actively carry out publications related to the theme of "formative assessment". The USA is the number one top country with 632 publications and 2463 citations and is followed by Spain with 220 with 1075 citations and Indonesia is in 6th place with 145 documentation and 97 citations. Apart from that, Malaysia is in last place with the number of documents while Italy is in the lowest ranking with 30 citations. The number of documents from each country has significant differences.

Most Productive Institution/Affiliate.

Table 2. Top 10 Productive Institution/Affiliate

No	Affiliate	Paper
1	Universitas Negeri Malang	26
2	University of California	25
3	Nanyang Technological University	17
4	Deakin University	16
5	Michigan State University	15
6	Umea University	15
7	Universidad De Valladolid	14
8	Utrecht University	14
9	University of Turin	13
10	University Of Nottingham	12

Based on Table 2 there are the top 10 universities that have the highest document production productivity related to "Formative Assessment". Malang State University is the most productive affiliate over the last 10 years with 26 documents and is the only domestic affiliate. Second place is the University of California with 25 documents and the University of Nottingham with 12 documents. From the picture above it is clear that formative assessments are often carried out abroad, marked by the level of publication productivity.

Table 3. Most Relevant Authors

No	Authors	Paper
1	Parno	15
2	Panadero E	11
3	Kusairi S	10
4	Deluca C	9
5	Latifah E	9
6	Marchsio M	9
7	Brown Gtl	8
8	Furtak Em	8
9	Ali M	7
10	Palm T	7

Figure 5 shows the level of writer productivity on the formative assessment theme. There are 10 authors with publications over 5 years old during the 2013-2023 period. Parno P is the writer with the highest level of productivity and has published 15 documents over a period of 10 years, and is followed by Panadero E with 11 documents published. Meanwhile, other writers have almost the same level of productivity as each other. Furthermore, there are also the same number of authors such as Deluca, Latifah and Marchisio with 9 publications.

Cp-Word Analysis. A total of 140 keywords were found from a minimum of 18 occurrences. Analysis of accompanying words shows that "Formative Assessment" is the keyword that appears most frequently (627 occurrences), followed by student (212 occurrences) and assessment (149). Table 1 shows 18 keywords based on word analysis based on top keywords. So, there are 4 clusters that describe the network structure of keyword occurrences simultaneously and are closely related to each other. The following is a cluster of shared quotations about formative assessment in learning.

Table 4. Most Relevant Authors

Cluster	Cluster Label	Number of articles
Red	Curriculula, Formative Evaluation, Learning Outcome,	7

	Learning systems, students, surveys, teaching	
Green	Asesment, Education, Highter Education, Learning Analytics, Blended Learning, learning	6
Blue	Highter Education, Online Learning, Teachers	3
Yellow	Assessment for Learning, Formative Assessment, Self-Assessment	4

Keyword cluster visualization.

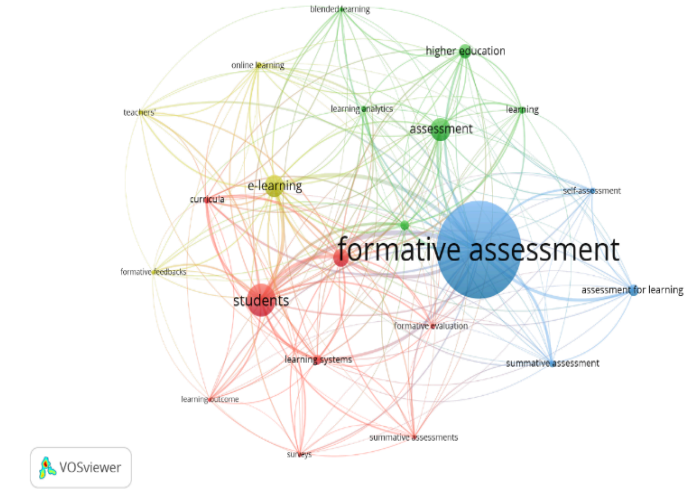

Fig. 2. co-word analysis of Assessment Formative

Based on Figure 3, the Vosviewer output displays the visualization of the results of the analysis of the relationship between clusters and keywords. Each cluster is given a different color to differentiate it from each other. Cluster 1 is marked in red, cluster 2 is green, cluster 3 is blue and cluster 4 is yellow. The largest circle with the keyword formative assessment shows that this keyword is frequently mentioned in the 627 publications analyzed. Meanwhile, the line shows the relationship or relationship between one keyword and another keyword.

Visualization analysis of each cluster.

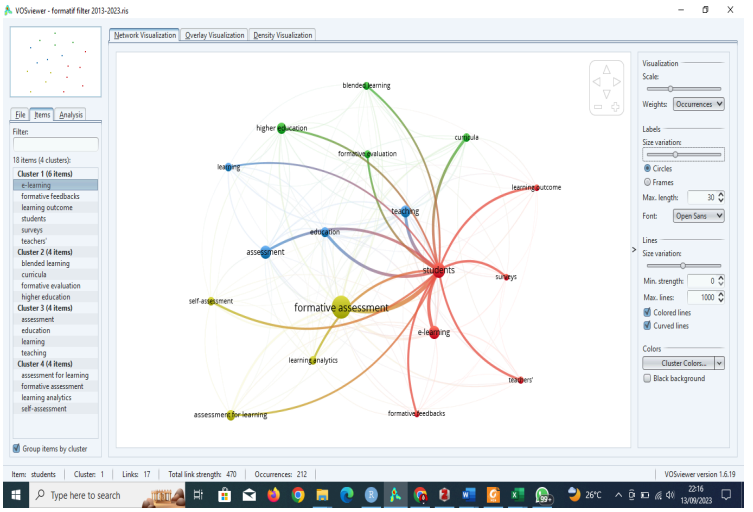

Fig. 3. One cluster

Based on the image of the visualization results from the Vosviewer output in the first cluster (red), the keyword that often appears is information, marked by the size of the dots. The picture of the 5 keywords "students", there is a significant relationship with other keywords and has a relationship with clusters 2,3, and 4 with 124 links, and a link strength of 1446. So, there are 6 keywords, namely e-learning, formative feedback, learning outcomes, students, surveys, and teachers. These keywords reflect elements related to information such as teaching, assessment, education, e-learning. In this case the student keyword has a strong relationship and is an element of other keywords.

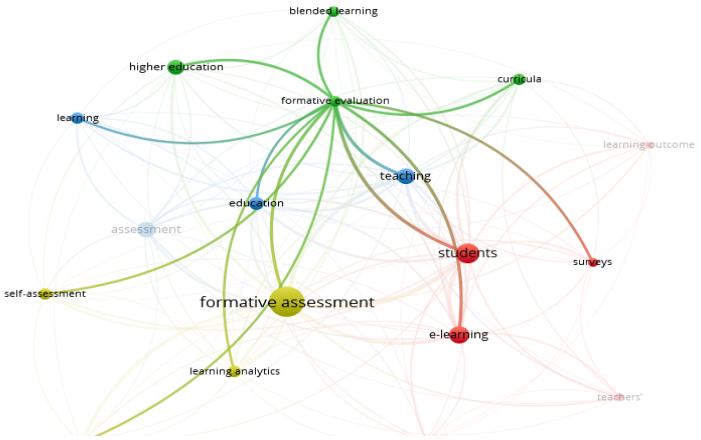

Fig. 4. Two cluster

Based on Figure 6, it shows cluster 2 with the keyword "higher education" and is related to other clusters. It has 96 occurrences with 124 links, and a link strength of 1446. Consists of a minimum of keywords, namely blended learning, curriculum, and formative evaluation. Apart from that, it has the strength of the keyword education, teaching, and learning. This is because higher education is one of the factors of these 3 keywords.

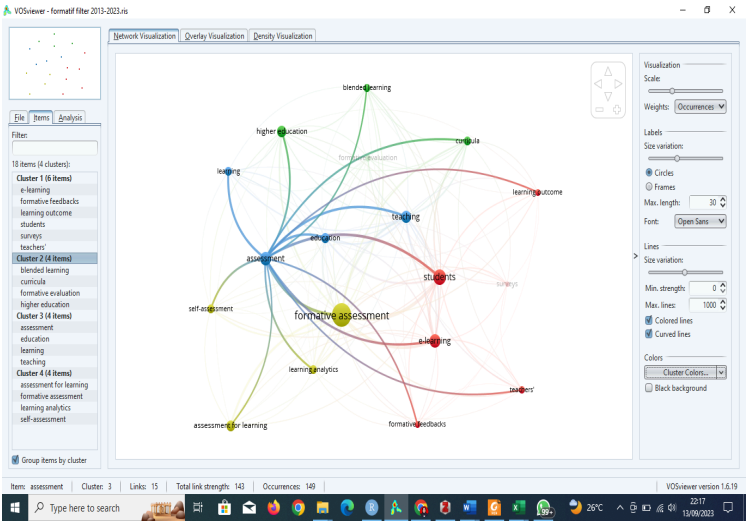

Fig. 5. Three cluster

Based on Figure 7, it is cluster 3 (blue) with the keyword "assessment" and is related to other clusters. Assessment has 149 opportunities with a total of 15 links and a link strength of 143. The assessment keyword is related to the main keywords, namely education, learning and teaching. As well as having strong relationships with students and formative assessment.

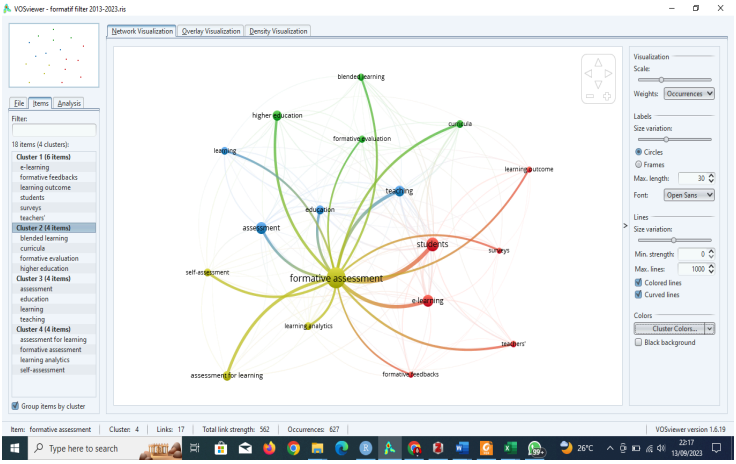

Fig. 6. Four cluster

Based on Figure 8, cluster 4 (yellow) has the keyword "formative assessment" which is the keyword that appears most frequently among other keywords. Formative Assessment has occurrences 627, links 17 and link strength 562 and has 3 main minimum links, namely assessment for learning, learning analytics and self-assessment. Apart from that, it has a strong relationship with all keywords. This reflects that formative assessment is an element of all keywords.

Future Research Opportunities. This research can provide valuable information for researchers about future research opportunities. Much research has been carried out on formative assessment. It can be seen in the density visualization in Figure 4, the brighter the color of a circle, the more frequently the keyword appears. Meanwhile, keywords that are dark in colors mean they are research topics that have not been studied much. So, this could be a candidate for discussion that can be discussed in the future.

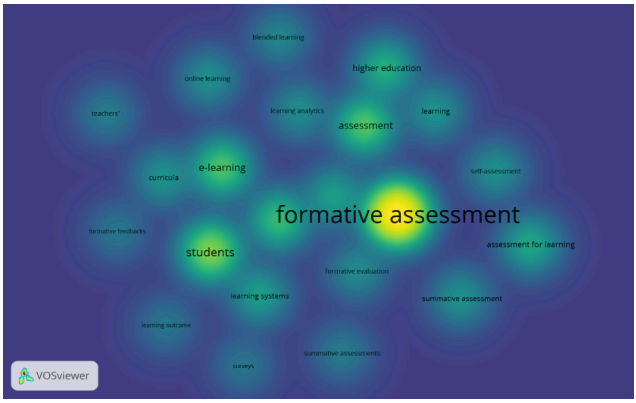

Fig. 7. DensityVisualization

3.2 **Discussion**

Carrying out assessments can help teachers understand the strengths and weaknesses of students. Formative assessment is one of the assessment processes used by teachers and students to recognize weaknesses and deficiencies and respond to student learning to improve the learning and learning process. The better the quality of the learning assessment, the better the teacher's understanding of students' strengths and weaknesses in studying a particular material and becomes a reference for teachers in making effective decisions in the learning process [11]. Besides that, formative assessment can be used to provide information about students' learning progress.

The usefulness of formative assessment, the importance of formative assessment in learning has become urgent, thus encouraging many researchers to study this matter. This is proven by the number of 1570 articles published over the last decade which proves that in the last 6 years there has been an increase, although not significant. However, this can be indicated that this topic is still a topic of interest for research. There was an increase in publications from 2015 to 2021 with the number of

publications above 100 articles and the highest peak in 2021 with a total of 203 articles.

Formative assessment is a keyword that often appears with a few occurrences of 627. This is proven by the development of research themes regarding the development of formative assessment instruments and their application in learning carried out by several researchers [12] and [13]. Based on several results, researchers identified that this research is still relevant to continue conducting. Apart from that, determining the implementation of the curriculum, especially in Indonesia, namely the Independent Curriculum which requires an educator to carry out diagnostic, formative and summative assessments [14]. So it is predicted that this research will continue to increase significantly in the future.

This can also be seen in the analysis results. Apart from that, the keyword student is number 2 with the highest occurrence, namely 212. This is because the research subject of formative assessment is carried out to measure weaknesses and strengths as well as the achievement of student learning outcomes [15]. On the topic of Formative Assessment, there are 4 clusters which can be seen in Figure 6, namely cluster 1 is marked red, cluster 2 is green, cluster 3 is blue, and cluster 4 is yellow. The four clusters formed have close relationships with each other. The analysis results with the largest circles for the formative assessment of keywords show that these keywords are frequently mentioned in the 627 publications analyzed. Meanwhile, lines show the relationship or connection between one keyword and other keywords. Apart from that, the affiliate with a high level of productivity is the State University of Malang with 26 articles. This shows that Indonesia still frequently conducts research on formative assessment.

This research is also able to provide information to researchers regarding future research opportunities. Information on the results of research that has been carried out using bibliometric analysis is the basis for further research to be able to examine topics related to formative assessment. The development of research on formative assessment is expected to have a significant impact on improving the quality of education, especially currently, the issue of education is the application of differentiated learning models that focus on student needs so that the importance of continuous assessment means that assessment is carried out from the time students start carrying out activities, during and after completion. carry out its activities.

4 Conclusion

Research mapping is an important thing as a basis for further research. Based on the results of mapping that has been carried out with the keyword "formative assessment" with Scopus article sources for the last 10 years, namely 2013-2023. The data collected is in the form of journals indexed by Scopus with a score of 1570. Research shows that the research trend experienced a significant increase starting in 2016-2021. The most productive institution/affiliation is the State University of Malang with 26 articles, the most productive country is the United States with 635 articles. The development of themes and keywords over time in the last decade shows that topics related to formative assessment are still of interest to researchers to continue to develop. This shows that the field is highly cited, with several articles, authors, and

journals. However, there are limitations to this research, namely that it only summarizes information based on the Scopus database. So, the interpretation is only limited to the findings contained in Scopus indexed journals.

Recommendations for future research in the field of assessment include research on themes and concepts that are still lacking, such as assessment using applications, assessments that are more interesting and practical. Research can also focus on understanding the implementation of assessment for each student's characteristics. In addition, future researchers are exploring more diverse databases such as Web of Science (WoS/WoK), Dimensions, Lens.org, Google Scholar, as well as several other metadata links to improve the accuracy of results and identify new trends.

5 Authors' Contributions

Jumriani Sultan conceptualized the research idea, designed the methodology, collected data, analyzed the data, and wrote the article. Sa'adatul Ulwiyah and Heri Retnawati provided corrections, suggestions and input on this manuscript.

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