Bibliometric Analysis of Process Oriented Guided Inquiry Learning Using R Package

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Abstract: This study aims to analyze research trends related to Process Oriented Guided Inquiry Learning (POGIL) using bibliometric methods with R software. The study explores: (1) the growth trend of publications on POGIL in 2014-2024 (2) institutions, and countries that are most productive in POGIL research, 3) scientific journals that have published articles on POGIL in 2014-2024, and the quality rating (SJR) of each journal, 4) the most commonly used independent and dependent variables in research on the POGIL approach in 2014-2024, 5) the dominant research methods and participants in POGIL research published between 2014 and 2024, 6) the types of learning media used in the implementation of the POGIL model based on research publications in 2014-2024. Bibliographic data were collected from the Scopus scientific database using specific keywords related to POGIL in science education. Furthermore, the data were analyzed using the bibliometrix package in R to generate visualizations. This visualization shows a comprehensive picture of the scientific contributions to the development and dissemination of the POGIL model. The results of this study are expected to be a reference for researchers, educators, and policy makers who are interested in developing research and implementing the POGIL model.

Keywords: Bibliometric, POGIL, Packages R, Research trend analysis

Introduction

In the field of education, the development of innovative teaching methods is quite important, the goal is to increase learner involvement so that it will get the desired learning outcomes. One of the innovative teaching methods is the Process-Oriented Guided Inquiry Learning (POGIL) learning model. POGIL is an inquiry-based active learning strategy that emphasizes structured group work where learners work collaboratively to build conceptual understanding, improve critical thinking skills, and develop communication and collaboration skills (Moog & Spencer, 2008; Farrell et al., 1999). The principle of the POGIL model is that effective learning occurs when learners actively construct their own knowledge, rather than simply receiving information. In practice, learners are placed in small groups with specific roles (such as manager, note-taker, and spokesperson), working systematically through a series of activities structured to lead them to discover scientific concepts (Hanson, 2006; Moog & Farrell, 2011). In addition, the POGIL model is supported by constructivism and social learning theory, which state that social interaction plays an important role in students' cognitive development (Vygotsky, 1978; Driver et al., 1994).

The POGIL learning model has been widely applied in several science lessons, such as chemistry, physics and biology. With the increasing research on POGIL, it is important to conduct a systematic analysis to find out how far this model has developed and influenced learning. To understand trends in POGIL research more broadly,

bibliometric analysis is a useful method. Bibliometric analysis allows researchers to map the structure and development of a field through quantitative assessment of publication metadata, such as the number of articles, citation patterns, collaboration between authors, and mapping of key research topics (Donthu et al., 2021; Zupic & Čater, 2015). This method can reveal how knowledge evolves, who are the most productive authors, institutions and countries in research on, how many journals have published POGIL-related articles and what are the most cited articles.

One of the most widely used tools in bibliometric analysis is the bibliometrix package developed for R studies, which offers complete analysis features including publication trend analysis, author and institution collaboration analysis, and conceptual mapping (Aria & Cuccurullo, 2017). In addition, integration with the igraph package enables interactive visualization of collaboration networks and relationships between documents or keywords, which can provide deep insights into the structure and dynamics of a particular research field (Csardi & Nepusz, 2006).

In this study, there are several research questions as follows:

1. What is the publication growth trend of the POGIL model in 2014 - 2024?
2. Which institutions and countries are most productive in research on POGIL in 2014-2024?
3. Which scientific journals have published articles on POGIL in 2014-2024, and what is the quality rating (SJR) of each journal in the context of science education publications?
4. What are the most common independent and dependent variables used in research on the POGIL model in 2014-2024?
5. What are the dominant research methods and participants in POGIL studies published between 2014 and 2024?
6. What types of learning media were used in the implementation of POGIL based on research publications from 2014-2024?
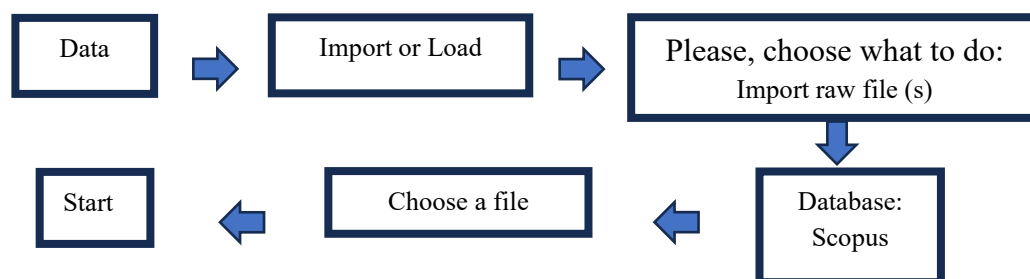
Method

This study uses bibliometric analysis to systematically examine and analyze research data. Bibliometric analysis is essential as it provides insight into knowledge development through quantitative measurement of scientific publications (Donthu et al., 2021). As a method that focuses on bibliographic analysis of scientific activities, bibliometrics assumes that the results can serve as a basis for future research (Chandra & Shang, 2019).
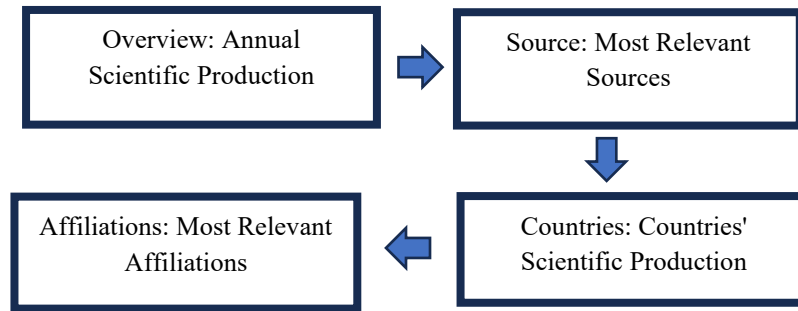
This study used the R application to run the bibliometric analysis. For first-time use, the bibliometrix package needs to be installed by typing "install.packages('bibliometrix')" in the console tab. Then, to run biblioshiny, type "library(bibliometrix)", press Enter or Run, and continue by typing "biblioshiny()" in the console tab, followed by Run.

Install.packages ("bibliometrix") → Indonesian → library(bibliomterix) → Biblioshiny ()
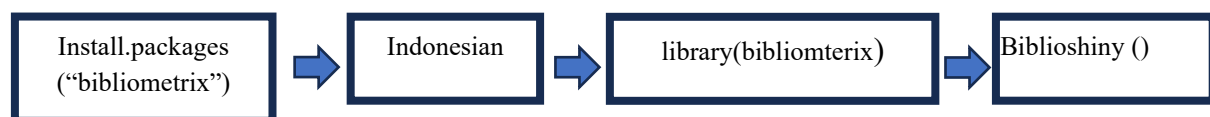
At this stage, RStudio successfully started biblioshiny: bibliometric. For analysis, data retrieval is required. The database used in this study was sourced from Scopus. The keyword entered was "POGIL in Science Education" The screening process was limited to publications from 2014 to 2024 and the type of articles selected were research articles. This ten-year period produced 9 documents, which were exported in bib format. Files in bib format were inserted into bibliometrix. The following are the steps to insert data into bibliomterix:

Data → Import or Load → Please, choose what to do: Import raw file (s) → Database: Scopus → Choose a file → Start

After clicking start bibliometrix will process the data automatically. After that, explore the data to be analyzed:

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┌─────────────────────┐       ┌─────────────────────┐
│  Overview: Annual   │  ⟹    │ Source: Most Relevant│
│ Scientific Production│       │      Sources        │
└─────────────────────┘       └─────────────────────┘
                                         ⇓
┌─────────────────────┐       ┌─────────────────────┐
│ Affiliations: Most  │  ⟸    │ Countries: Countries'│
│ Relevant Affiliations│      │ Scientific Production│
└─────────────────────┘       └─────────────────────┘
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In addition, to obtain more specific data such as independent variables, dependent variables, methods, participants and also learning media used in POGIL research, content analysis was carried out by reading and directly reviewing articles obtained from Scopus.

Results and Discussion
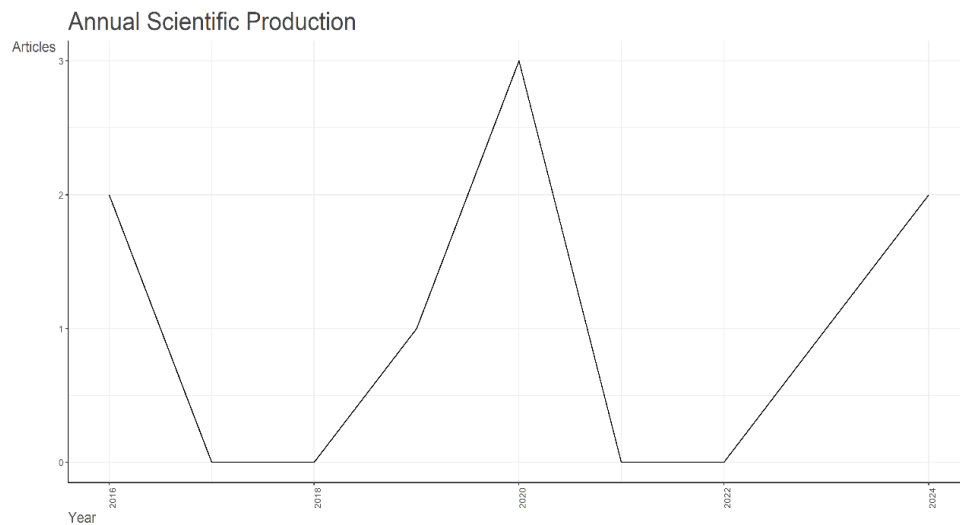
Publication Trends

Figure 1. Annual scientific production

Picture 1 shows the Annual Scientific Production graph. The horizontal axis (X) shows the years from 2014 to 2024, and the vertical axis (Y) shows the number of articles published each year. This graph illustrates the fluctuation in the number of publications from year to year. There is an increase in the number of articles published in certain years and also a decrease in certain years. Article production peaked around 2023, with a total of 3 articles published. In 2021 to 2022 there was a decrease, this may have occurred due to the Covid-19 pandemic.

The Most Productive Institutions, and Countries

Most Productive Institutions

From the graph, it can be seen that State University of Malang, Curtin University, University of Papua are the institutions with the most contributions, namely two articles. Followed by other institutions which each contributed one article. This graph provides an overview of the distribution of publications based on institutional affiliation, which can be used as a reference to identify institutions with the most significant contributions in a particular study or research field.
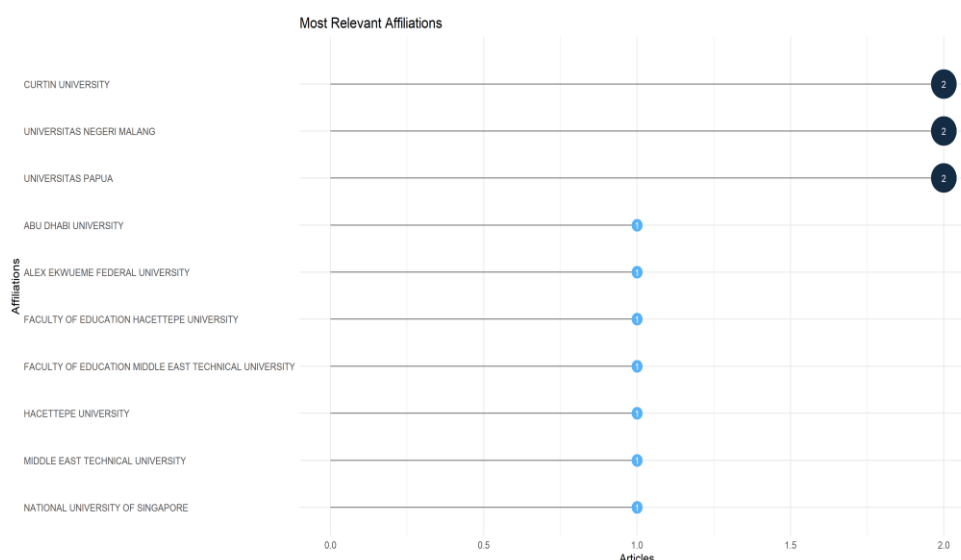
Figure 2. Most relevent affiliations

Most Productive Country

Table 1 shows the frequency of scientific article contributions based on the author's country of origin or institutional affiliation. Based on the data in the table, Indonesia is the country with the highest contribution. Followed by other countries such as Turkey, Australia, Nigeria, Qatar, Singapore, South Africa and the United Arab Emirates. This data provides an overview of the geographical distribution of research results or scientific publications, which can be an indicator of the level of participation or scientific contributions from various countries in a particular field of study.

Table 1. Most productive country

Country	Freq
Indonesia	5
Turkey	4
Australia	2
Nigeria	1
Qatar	1
Singapur	1
South Africa	1
United Arab Emirates	1

Scientific Journals Published in POGIL Between 2014 and 2024 and the Quality Rating (SJR) of Each Journal

Table 2. Journals that publish POGIL

Sources	Articles	SJR
African Journal of Research in Mathematics, Science and Technology Education	1	Q3
Asia-Pacific Forum on Science Learning and Teaching	1	Q4
European Journal of Educational Research	1	Q3
Interactive Learning Environments	1	Q1
Participatory Educational Research	1	Q3
Research in Science Education	1	Q1
TEM Journal- Technology, Education, Management, Informastics	1	Q3
Turkish Online Journal of Educational Technology	1	Diskontinu
Universal Journal of Educational Research	1	Diskontinu

Table 2 shows a list of journals or scientific publication sources that publish POGIL articles. This diversity of sources reflects that the field of research analyzed has a broad scope and attracts attention from various scientific

communities across disciplines and countries. Moreover, this even distribution also indicates that no single journal dominates the publications in this context, thus showing a balanced distribution of scientific contributions from different academic sources. The quality rating (SJR) of each journal also differs from Q1, Q3 and Q4. There are also journals that have been discontinued.

Independent and Dependent Variables

Table 3. Independent and dependent variables

Paper	Independent variable	Dependent variable
Development of Integrated Physics Learning Tools in Virtual Laboratory Platform: Its Implementation through the POGIL Strategy in Indonesian Frontier Areas	POGIL	Students' understanding and ability to conduct experiments
The Frontier Areas' Student Acceptance of Physics Fun-based Mobile Application: Incorporating the Process-Oriented Guided-Inquiry Learning (POGIL) Strategy	POGIlL	Physics Fun application usage behavior
The influence of process oriented guided inquiry learning (POGIL) model assisted by realia media to improve scientific literacy and critical thinking skills of primary school students	Process Oriented Guided Inquiry Learning (POGIL) Model	Improving students' scientific literacy and critical thinking skills
Effects of process-oriented guided inquiry learning on approaches to learning, long-term performance, and online learning outcomes	POGIL	Learning outcomes
Non-randomized Trial of POGIL for Improving Undergraduates' Academic Achievement in Science Education	POGIL	Academic Achievement
Process-Oriented Guided Inquiry Learning (POGIL) as a Culturally Relevant Pedagogy (CRP) in Qatar: a Perspective from Grade 10 Chemistry Classes	POGIL	Academic achievement
Refining Process-oriented Guided Inquiry Learning for Chemistry Students in an Academic Development Program	POGIL	Student responses and behavior towards POGIL
The effect of Process Oriented Guided Inquiry Learning (POGIL) on 11th Graders' conceptual understanding of electrochemistry	POGIL	Concept understanding
High school students' views about Process Oriented Guided Inquiry Learning (Pogil)	POGIL	Students' views on POGIL

The application of the Process-Oriented Guided Inquiry Learning (POGIL) model in various studies shows a positive contribution to improving the quality of learning at various levels of education. The POGIL model is one of the models used in research, especially in science education research. In these studies, besides being able to improve concept understanding, POGIL can also improve students' science literacy and critical thinking skills. In addition, POGIL can also improve learning outcomes or academic achievement and POGIL also gets a good response from students or students.

Methods and Participants

Research that examines the application of Process-Oriented Guided Inquiry Learning (POGIL) shows diversity in the use of research methods. Based on the analysis of several studies, the methods used include quantitative methods, qualitative methods, mixed methods and ADDIE. This diversity reflects researchers' efforts to understand the effectiveness of POGIL from various perspectives, both through numerical measurements and exploration of learners' learning experiences. From this diversity of methods, it can be concluded that the POGIL approach is explored not only through rigorous numerical data, but also through rich narratives and learning experiences. This demonstrates the flexibility and breadth of POGIL's potential to be applied and researched in a variety of educational contexts and across different levels of learners. POGIL can also be implemented for learners

from elementary school, high school, to university students. This shows that POGIL is flexible and adaptive to various levels of learner development.

Table 4. Methods and participants

Paper	Method	Participant
Development of Integrated Physics Learning Tools in Virtual Laboratory Platform: Its Implementation through the POGIL Strategy in Indonesian Frontier Areas	ADDIE	54 Students
The Frontier Areas' Student Acceptance of Physics Fun-based Mobile Application: Incorporating the Process-Oriented Guided-Inquiry Learning (POGIL) Strategy	Quantitative methods	136 students participated
The influence of process oriented guided inquiry learning (POGIL) model assisted by realia media to improve scientific literacy and critical thinking skills of primary school students	Quantitative methods	fourth grade elementary school students
Effects of process-oriented guided inquiry learning on approaches to learning, long-term performance, and online learning outcomes	Mix Method	170 students
Non-randomized Trial of POGIL for Improving Undergraduates' Academic Achievement in Science Education	Quantitative Methods	85 science education students
Process-Oriented Guided Inquiry Learning (POGIL) as a Culturally Relevant Pedagogy (CRP) in Qatar: a Perspective from Grade 10 Chemistry Classes	Mixed method	Grade 10 students
Refining Process-oriented Guided Inquiry Learning for Chemistry Students in an Academic Development Program	Qualitative methods	Student
The effect of Process Oriented Guided Inquiry Learning (POGIL) on 11th Graders' conceptual understanding of electrochemistry	Quantitative methods	115 students in grade 11
High school students' views about Process Oriented Guided Inquiry Learning (Pogil)	Qualitative	Grade 11 students

Learning Media

Table 5. Learning media

Paper	Instructional Media
Development of Integrated Physics Learning Tools in Virtual Laboratory Platform: Its Implementation through the POGIL Strategy in Indonesian Frontier Areas	Integrated physics learning tools in a virtual laboratory platform
The Frontier Areas' Student Acceptance of Physics Fun-based Mobile Application: Incorporating the Process-Oriented Guided-Inquiry Learning (POGIL) Strategy	Physics Fun-based Mobile Application
The influence of process oriented guided inquiry learning (POGIL) model assisted by realia media to improve scientific literacy and critical thinking skills of primary school students	Real media
Effects of process-oriented guided inquiry learning on approaches to learning, long-term performance, and online learning outcomes	V-Lab and Physics Fun application integrated with POGIL strategy
Non-randomized Trial of POGIL for Improving Undergraduates' Academic Achievement in Science Education	LKS POGIL manual
Process-Oriented Guided Inquiry Learning (POGIL) as a Culturally Relevant Pedagogy (CRP) in Qatar: a Perspective from Grade 10 Chemistry Classes	Teaching materials
Refining Process-oriented Guided Inquiry Learning for Chemistry Students in an Academic Development Program	Worksheet
The effect of Process Oriented Guided Inquiry Learning (POGIL) on 11th Graders' conceptual understanding of electrochemistry	Worksheet
High school students' views about Process Oriented Guided Inquiry Learning (Pogil)	POGIL smart board and activity sheets

Theapplication of the Process-Oriented Guided Inquiry Learning (POGIL) model in various studies shows a positive contribution to improving the quality of learning at various levels of education. From the data analyzed, POGIL is the main independent variable which in some studies is combined with media assistance such as Physics Fun-based Mobile Application and realia media. This combination aims to enrich the inquiry-based learning process by utilizing technology.

Conclusion

During the period 2014 to 2024, research on the Process-Oriented Guided Inquiry Learning (POGIL) learning model fluctuated. This occurred due to several factors, one of which was the Covid-19 pandemic. Institutions in Australia and Indonesia, such as Curtin University, State University of Malang and University of Papua, are listed as active contributors in publications related to POGIL. Meanwhile, when viewed from the author's affiliation, Indonesia is a country that has active contributors in POGIL publications. While globally, journals such as Interactive Learning Environment which has the SJR Q1 ranking index is one of the main media for disseminating research results.

Research on POGIL generally uses an independent variable in the form of a learning model (POGIL with or without specific media integration), while the dependent variable that is most often analyzed includes academic achievement or learning outcomes. The research methods used vary from qualitative, quantitative and mixed methods, with participants coming from elementary, high school and university students. In its implementation, POGIL utilizes many innovative learning media such as Physics Fun-based Mobile Application, realia media and V-Lab. Thus, it can be concluded that POGIL is an adaptive and effective learning model in improving the quality of science learning, which continues to grow both in terms of methodology, supporting media, and the scope of research.

Recommendations

For future research, comparison of analysis results using bibliometrix package with other tools or methods can be included to evaluate the effectiveness of using R in bibliometric analysis.

Scientific Ethics Declaration

* The authors declare that the scientific ethical and legal responsibility of the article published in this EPESS journal belongs to the authors.

Conflict of Interest

* The authors declare that they have no conflicts of interest

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