Pegem Journal of Education and Instruction, Vol. 13, No. 1, 2022 (pp. 360-366)

RESEARCH ARTICLE WWW.PEGEGOG.NET

Trends of English as Medium Instruction in Science Learning: Review and Bibliometric Analysis

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Abstract

This research aims to find new ways of teaching science by providing an extensive bibliometric literature review on 'English as Medium Instruction - EMI' in science classrooms. This research used a total of 996 that were retrieved from Publish or Perish software (PoP) with a Google Scholar database. The selected articles were organized using a reference manager software, namely Zotero. The data were then classified and visualized using VOSviewer software. This review provides an appropriate reference point for further research on 'English as a Teaching Intermediate -EMI' in science classrooms. The results show that EMI has the potential to be implemented as a teaching medium in non-native English speaker countries. The bilingual EMI teaching strategy can be developed as a strategy to build mastery of concepts as well as English communication skills for non-native English students in Indonesia.

Keywords: bibliometric analysis, bilingual, EMI, science class.

Introduction

The use of English as the language of instruction in schools aims to support the development of a generation of Indonesians who are reliable, competitive, and able to collaborate globally (DEPDIKNAS, 2006). This happens because most of the literatures and academic articles from around the world are generally available in English, one of which is material for the field of education (Sukardi et al., 2021). Patonah and Irawan (2020) revealed that the use of English as the language of instruction in schools is one of the reforms in the field of teaching that has a futuristic mission in equipping the young generation of Indonesia with subject competence and language competence.

The trend of using English as the language of instruction in schools (*English as Medium Instruction* - EMI) was popular in Indonesia in the early 2000s along with the issuance of government policies through UUSPN 20/2003 article 50 paragraph 3 related to international-oriented implementation education programs. EMI is broadly defined as the use of English to teach academic subjects in a country or jurisdiction where the first language or the mother language of the majority of the population is not English (Soruç & Griffiths, 2018). Thus, Indonesia tried to implement EMI in their curricullum, but it cannot be separated from the government's policy of opening the International Standard School Pioneer (*Rintisan Sekolah Berstandar Internasional – RSBI*) program. However, after the disbandment of the RSBI program in early 2013 with the issuance of the Constitutional Court, EMI seemed to disappear immediately.

The results of an investigation conducted by the British Council show that the mastery of English for primary and secondary school students in Indonesia is very concerning (Sukardi et al., 2021). Further investigation showed that most schools that offer science teaching with EMI generally adopt a *Content and Language Integrated Learning* (CLIL) approach. This approach facilitates students to understand the content of the material as well as deepen their English grammar (Margana, 2015; Surdyanto, 2018). This strategy is certainly not easy to be implemented for non-native English country like Indonesia because the study of science is not limited to the use of instructional sentences, but it also includes the basic science concepts that must be maintained coherently to avoid any misconceptions (Márquez & Porras, 2020; Ünsal et al., 2018). In some Asian countries, the application of EMI is still very

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How to cite this article: Sukardi RR, Sopandi W, Riandi, Lestari H, Juanda MR (2022). Trends of English as Medium Instruction in Science Learning: Review and Bibliometric Analysis. Pegem Journal of Education and Instruction, Vol. 13, No. 1, 2022, 360-366

Source of support: This research did not receive any specific grant from funding agencies in the public, commercial, or not-for-profit sectors.

Conflict of interest: None.

DOI: 10.47750/pegegog.13.01.39

Received : 20.04.2022

Accepted : 07.07.2022 **Published:** 01.11.2022

massive, such as in South Korea, China, and Bangladesh because it has contributed to the progress of education in these countries (Ducker, 2019). This findings show that EMI also has the opportunity to be developed in Indonesia. The question is, what strategy that is suitable for applying EMI to science subjects in Indonesia.

In Indonesia, using EMI to teach science classes can be challenging because English is not the mother tongue and the first language of most Indonesian. However, the facts show that English has become the lingua franca in various strategic sectors including the development and publication of the latest science and technology as well as teaching in schools (Lauder, 2020; Rahman & Pandian, 2018). Meanwhile, science as a scientific discipline has some unique characteristics such as scientific terms that can only be understood by people who have scientific background. It can lead to misunderstandings about the meaning of some scientifc terms if science is taught in a foreign language (Giles & Yazan, 2020; Sukardi et al., 2021). Moreover, data published by the British Council shows that the English language skills of primary and secondary school students in Indonesia need to be seriously improved. What teachers need to pay attention to when teaching science with EMI is the depth of understanding and mastery of students' concepts. Teachers must ensure that English does not become a barrier for students to understand the basic concepts of science. The use of foreign languages in teaching has a great relation to the science subject itself because if students cannot understand the language, then it will hinder students' learning progress. On the other hand, it will bring great benefits if the use of foreign languages is formulated appropriately according to students' conditions. (Coleman et al., 2018). The same thing was also stated by Lauder (2020) that the use of foreign languages must be appropriate and within the range of understanding of students to minimize learning barriers.

The RSBI program had been dismissed in 2013 because it received a lot of criticism from the public. Despite of this fact, some schools in Indonesia still implemented the use of EMI in their school system due to the increase of demands for learning English from parents who have more awareness regarding the importance of English for their children. However, have these schools succeeded in improving students' proficiency, not only in the use of English, but also in acquiring subject knowledge? There is a need for intensive research to answer this question. A more mature preparation can provide detailed instructions to produce a teaching approach that is more practical and fulfills the purpose of using EMI (Khasbani, 2019). What must be ensured is how well EMI is applied in various fields of science, including the scientific field, so that the purpose of providing language skills and scientific content can be achieved.

The students' succesful rate in learning language and science subject cannot be separated from their emotional state in learning process, especially anxiety. According to some research, anxiety affects input (taking in new information), processing (incorporating new information into existing information and retrieving schemas), and output abilities (verbal production) (Dörnyei, 2008; Teimouri et al., 2019). In most language learning research, anxiety is considered to have a debilitating effect that causes students to avoid learning activities. In recent years, there is an increased attention of research on language learning anxiety and its effect on student participation in class and language performance on tests. In this study, anxiety was caused by a lack of confidence in speaking and fear of actively participating in class. Many strategies have been carried out in English speaking countries, English as a Second Language (ESL) or EFL contexts to date, but not on how certain situational variables, i.e., full EMI versus partial EMI, affect students' speaking anxiety during learning, not except in Science (Chou, 2018).

Rose et al. (2020) reported that knowledge of English and academic English skills were statistically significant predictors of academic. This indicates that EMI needs to be strengthened with mother tongue support for students with lower language skills. Macaro et al. (2018) reported such concerns in Turkey, United Arab Emirates, Spain, France, China, Iraqi Kurdistan, South Korea, and Sweden. This concern was confirmed in the report of Galloway et al. (2017), which states that linguistic problems in EMI can lead to a lack of understanding of the concept and context of the material, long time to complete lessons, increased likelihood of dropping out, and lack of active involvement in the classroom. It indicates the need for the right strategy to convey knowledge in English, as well as retain the concept as a whole to students.

Some of the vocabulary of Science in Indonesian does not have a significant difference with the translation in English. This is one of the factors that make it easier for students who study Science with EMI. The results of the research by Sukardi et al. (2021) show that the keywords to understand the explanation of Science in English are simple and often spoken vocabulary in everyday life, for example, evaporation, condensation, and melting point. Understanding Science keywords are expected to reduce anxiety in understanding Science instructions and explanations with EMI.

Considering the above reasons, this study aims to illustrate the research gap by providing an extensive bibliometric analysis of the literature related to the use of EMI in science lessons in Indonesia. Articles published and indexed by *Google Scholar* (GS) are analyzed. This analysis can see research topics from many publications and EMI topic opportunities for further research in the future. The methodology used to carry out the analysis is to use bibliometric analysis, including method steps related to the implementation of GS and *Publish or Perish* (PoP) data-based software. Then present the results using the *VOSviewer* followed by a discussion and conclusions from the literature study using the bibliometric analysis that

has been carried out. The focus of this research is to find a new alternative of teaching science with EMI strategies that are suitable for the conditions of students and the curriculum in Indonesia based on the review and bibliometric analysis. Moreover, this research also contributes to the development of English teaching by providing the importance of EMI in improving students' mastery of concepts and their English communication skills.

Method

General Background of Research

This bibliometric research method adopts the five-step method developed by Tranfield et al. (2018), namely determining search keywords, collecting initial search results, refining search results, compiling initial data statistics, and analyzing data. This method was used to provide a systematic overview of the existing comprehensive body of literature of the use of EMI the field of education (Nische et al., 2021; Peixoto et al., 2022). Therefore, it is important used a solid and widely accepted method to reduce bias and increasing reliability and validity.

Procedures and Data Analysis

The first step is to conduct a literature search with the keywords '*English as Medium Instruction*' and '*Science Class*'. Google Scholar was chosen because it is the largest database and Publish or Perish was chosen because it proved to be the most effective way to search for articles on GS (Hudha et al., 2020). The second step is to do a special search in the time range 2005-2021. A total of 996 articles in the journal were found in the initial search. The results are compiled in a *Research Information System* (RIS) format to include all important article information such as paper title, author name and affiliation, abstract, keywords, and references. The third step is to filter and select articles in GS. Proceedings of international seminars, book reviews, book reviews, book sub-chapters, and opinions in the mass media are not selected. The filtered data is then stored in the form of a RIS file and imported into the Zotero bibliographic tool. The fourth step is to revise the data contained in the RIS. At the initial stage, it is necessary to ensure the completeness of the components of the journal article which contains the year of publication, volume, number, and pages. The components are checked and the necessary information is changed if the available data is incomplete. The fifth step is to do a bibliometric analysis with *Publish or Perish* (PoP) software. To obtain a visualization of the bibliometric network, *Vosviewer* software is used which can work efficiently in providing a variety of interesting visuals, analyses, and investigations (Donthu et al., 2021; Hudha et al., 2020). *Vosviewer* can also create publication maps, author maps, or journal maps based on co-citation networks or build keyword maps based on shared networks.

Findings

The results of bibliometric analysis using PoP software show that of the 996 journal articles on GS for the 2005-2021 publication year, the number of citations is 21,996 for the keywords EMI and science class. The average citation per year is 1374.75 while the average citation per article is 22.08. This indicates that the EMI and science class themes still have the potential to be further developed for various research purposes. Complete data related to bibliometrics can be seen in Figure 1.The researcher tries to present the most relevant contributions in this research. The steps taken were to take articles with the keywords "*English as Medium Instruction*" and "science class" which had the highest citation scores (10 top articles cited) as presented in Table 1. The articles that were cited the most were indexed in the reputation category a very good journal. The keywords and titles presented also have very good visibility and are "eyes catching" so that they are easily accessible to information seekers.

The ten articles with the highest citations in Table 1 indicate that their research focus is on the practice of using EMI in teaching, including science in countries such as Malaysia, China, Hong Kong, Italy, and Sweden. These articles describe in detail how English is used as a medium of instruction in a country where the mother tongue is not English. Of course, the decision to use EMI has been studied in detail with sustainable futuristic goals, including supporting policies. The articles also present facts, data, targets, and reflections related to the EMI program. One article even mentions that multilingualism is one of the strategies used in adapting to the difficulties of using EMI.

The strategy that is commonly used in the implementation of EMI is the deepening of concepts and learning of linguistic content which are carried out simultaneously. Although various difficulties came, it did not dampen the use of EMI in various

Publication years:	2005-2021
Citation years:	16 (2005-2021)
Papers:	996
Citations:	21996
Cites/year:	1374.75
Cites/paper:	22.08
Authors/paper:	1.75
h-index:	70
g-index:	129
hI,norm:	60
hI,annual:	3.75
hA-index:	28

Fig. 1: Data of Bibliometrics

schools in non-native English countries. This indicates that the curriculum used in that country is also more flexible and allows students' self-development. Getting a good mastery of science concepts as well as good English communication skills, is not an instant thing to be realized immediately. Everything requires a continuous process and is supported by a measurable vision and mission. Higher education is one of the segments targeted for EMI implementation in various countries, including Indonesia. Almost all universities in Indonesia use English books as the main reference source in lectures. This shows that regardless of whether or not EMI is used, students and students need to understand English as a language that brings up-to-date knowledge (Sukardi et al., 2021).

Figure 2 shows the network visualization of Google Scholar's data on EMI and science classes. It can be seen in the picture that some words that appear are the tendencies of the variables studied. The word instruction is a word or variable that has been widely studied regarding EMI. In addition, the

Table 1: Ten Articles with the Best Citation.

No.	*Author(s)*	*Titles*	*Publisher*	*Journal*	*Year*	*Total of Citation*
1	E Macaro, S Curle, J Pun, J An, J Dearden	A systematic review of English medium instruction in higher education	Cambridge University Press	Language Teaching	2018	697
2	K Byun, H Chu, M Kim, I Park, S Kim, J Jung	English-medium teaching in Korean higher education: Policy debates and reality	Springer	Higher Education	2011	444
3	A Doiz, D Lasagabaster, JM Sierra	Internationalization, multilingualism, and English-medium instruction	Wiley Online Library	World Englishes	2011	369
4	J Cenoz	Content-based instruction and content and language integrated learning: The same or different?	Taylor & Francis	Language, culture, and curriculum	2015	345
5	S Evans, B Morrison	Meeting the challenges of English-medium higher education: The first-year experience in Hong Kong	Elsevier	English for Specific Purposes	2011	331
6	U Smit, E Dafouz	Integrating content and language in higher education: An introduction to English-medium policies, conceptual issues and research practices across Europe	AILA	AILA Review	2012	330
7	K Bolton, M Kuteeva	English as an academic language at a Swedish university: Parallel language use and the 'threat of English	Taylor & Francis	Journal of Multilingual and Multicultural …	2012	326
8	F Costa, JA Coleman	A survey of English-medium instruction in Italian higher education	Taylor & Francis	International Journal of Bilingual Education …	2013	305
9	G Hu, J Lei	English-medium instruction in Chinese higher education: A case study	Springer	Higher Education	2014	284
10	JA Coleman	English-medium teaching in European higher education	Cambridge University Press	Language teaching	2006	87

names of countries that represent the place of implementation of EMI in various fields of science and the purpose of using EMI such as globalization and internalization also appear. The words literature and anxiety appear in the network visualization which indicates that in the implementation of EMI there will be student anxiety. Literacy is needed by students to add insight related to vocabulary in English which is a foreign language for students. A more detailed network visualization related to EMI is presented in Figure 3..

Figure 3 shows an enlarged or focused network visualization for specific keywords. The important keyword is the instruction which represents how the teaching process is carried out in English. From the nets in Figure 3, information is obtained that the EMI program is generally applied to various subjects such as mathematics and science at universities in Indonesia and Malaysia. However, based on the appearance of Figure 3, there is no specific strategy for how EMI is applied in Indonesia, which is a country with a non-native British population.

Figure 4 shows the timeline of each keyword in the network overlays up to 2019. This visualization overlay analysis is used to identify key themes in each study or scope of knowledge (Liu et al., 2015). EMI as a teaching strategy has been studied since 2016 in various fields of science such as mathematics

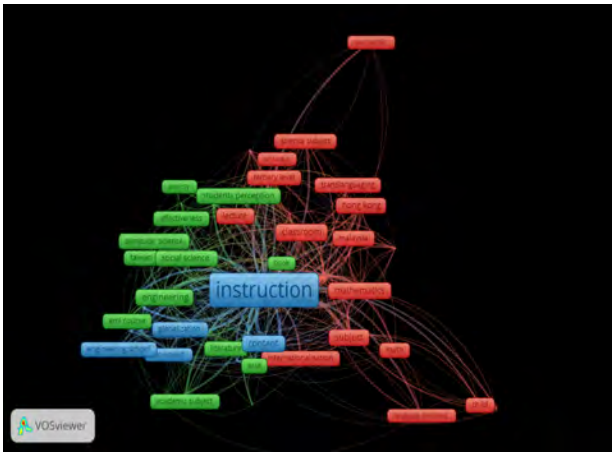

Fig. 2: Network Visualization on Google Scholar Data

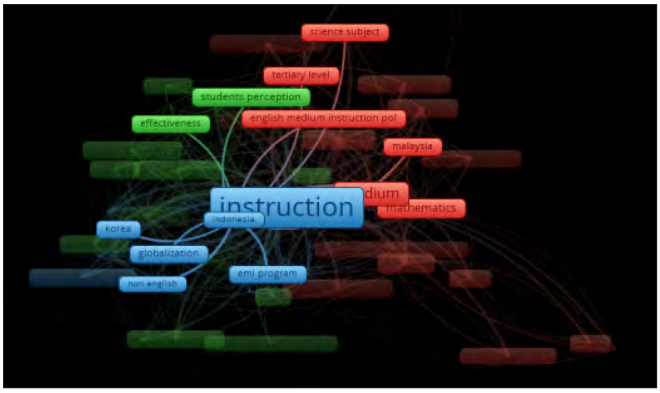

Fig. 3: Zoom Network Visualization on Google Scholar Data

Fig. 4: Network Overlays on Google Scholar Data.

and engineering in Malaysia. However, EMI research as a teaching strategy in certain subjects with supporting book supplements is a relatively new area because it has been researched since 2019. The latest research opportunities based on the appearance of networks visualization and networks overlays are a science teaching strategy with EMI supported by the use of books. English textbook for Indonesian students who are non-native English speakers. In addition, Indonesian students need a strategy or learning model that 'forces' students to read texts, especially those in English because apart from practicing reading comprehension, they also increase their vocabulary in English. Students also need an active forum in class in small or large groups to practice speaking or verbal communication skills. The EMI teaching strategy bilingually seems to be a wise choice to build mastery of concepts as well as students' communication skills because science is a concept that must be fundamentally coherently maintained so that there are no misconceptions (Sukardi et al., 2021).

Discussion

The matter of concern is related to further research opportunities from this bibliometric data. Table 1 shows implicitly that the trend of using EMI in learning is still very high even though there are various obstacles such as the emergence of excessive student anxiety. However, the right strategy is believed to provide a good solution. The use of EMI in learning has futuristic goals not only related to internalization and globalization but also related to the development of sustainable human qualities. Many East Asian countries adopt EMI in their education systems and can produce superior outputs.

Figures 2 and 3 indicate that there are opportunities to implement EMI in Indonesian science classes at the primary and secondary school levels in Indonesia. The results of research published by the British Council which states that the quality of learning in classrooms using EMI is very poor in Indonesia (Soruç & Griffiths, 2018), should be a reflection of how the EMI strategy can be applied wisely according to the

conditions of students and the curriculum in Indonesia. The fact that Indonesian students are non-native English speakers should be one of the special considerations. Students are most likely to have difficulty understanding their explanations in English. There is a coherence of scientific concepts that must be maintained fundamentally but at the same time, English language skills must also be trained. This is understandable because, from the educational history of the Science teachers, they do not have an adequate English background to carry out learning in these foreign languages. The frequency of using English as the language of instruction varies depending on the type of subject and the teacher who teaches the subject. This should not obscure the essence of learning science concepts thoroughly and thoroughly. This indicates that under certain conditions, English must be accompanied by the Indonesian language so that a bilingual strategy is an option. According to Seikkula Leino (2007), the use of English as the language of instruction will not interfere with the use of students' first language (Indonesian). This is due to the diglossia phenomenon where students unconsciously build the habit of using two languages in different situations, namely: using the first language (Indonesian) in everyday life and English in an academic atmosphere at school.

Novelty is one of the priorities in research. Figure 4 shows that the strategy for using EMI using textbooks is still very potential to be developed. The steps in using this book support the improvement of students' reading literacy. This increase will certainly have an impact on increasing students' mastery of concepts in science material as well as increasing their vocabulary in English. The next challenge is how to use textbooks with strategies that can accommodate various conditions of students and the curriculum in Indonesia in implementing EMI in a practical, effective, and efficient manner. This needs to be supported by the ability of teachers and students to take advantage of these textbooks. If the English language skills of teachers and students are adequate in the learning process, it can be expected that learning achievement and students' English skills will increase.

The results of this bibliometric analysis have a significant impact on both teachers and other educators. The results of the bibliographic analysis show that the implementation of EMI in both science and other classrooms does not implement a specific strategy that can meet the needs of students with a deep understanding of English lesson text and science content. These results also pave the way for other studies, such as the use of EMI in the science classroom to gain a better understanding of the basics of residual science and English communication skills.

Conclusion

In conclusion, EMI has the opportunity to be developed as a teaching medium in non-native English speaker countries because it produces superior outputs. Many non-English countries used English as the medium for their teaching whereas some of those countries originated from Southeast Asia and they have implemented the use of EMI in their curriculum. The results of bibliometric mapping and document analysis show that the bilingual EMI teaching strategy has the opportunity to build mastery of concepts as well as English communication skills for non-native English students in Indonesia. This research shows the potential of using the bilingual EMI teaching strategy by giving science related keywords for students in English, while using Indonesian language for the language of instruction. Thus, it is recommended for government to improve the implementation of EMI in Indonesia since EMI can help increase the students understanding on the study of concept as well as improving their English communication skills.

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