Science E-module : A Literature Review and Bibliometric Analysis

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Abstract:. *This study aims to analyze and describe trends in the research and development of science electronic module (e-module). The research methods used in this study combine the literature review and bibliometric analysis conducted using Publish or Perish (PoP) and VOSViewer software. The five-step bibliometric analysis method is adopted. Based on the result, 83 papers during period 2018-2023 about 'Science E-Modules' are obtained from Google Scholar. Based on the results, it can be concluded that articles about science e-module in the period 2018-2023 witnessed a drastic increase from 2020 to 2022, which confirms that science e-module is a promising and prevalent research domain. The bibliometric analysis results indicate that the most topics to address regarding the science e-module are those related to STEM (Science, Technology, Engineering and Mathematics) and science process skill. In further research, science e-modules can be developed with other topics that have not been discussed before or by combining several topics into a new topic such as ethno-STEM to improve scientific literacy.*

Keywords: *e-module, bibliometric analysis, literature review, VOSViewer*

1. INTRODUCTION

Towards the 21st century, the development of science, information and technology is expeditious. Technology has an important influence on the education sector, for example in learning methods, the learning environment, and assessment (Devore & Singh, 2020). Today, students require to learn that is no longer just traditional academic learning but education that offers learning services that renew them to collaborate, communicate and solve problems, think critically, creatively, and innovatively (Greenstein, 2012).

On the other hand, teachers as educators must be prepared to face this challenge to provide the best educational services for students. The integration of technology in the learning process is crucial in today's digital era so that educators not only have content and pedagogical knowledge components but must also support by the ability to integrate these two components with technology (McKinnon & Vos, 2015).

Moreover, this condition is supported by the education system which has changed in two years due to the Covid-19 pandemic. With this pandemic, the learning system that was originally carried out offline in the classroom must change to online in the internet space. In this pandemic time, the use of information technology to support the learning process was massively used.

As a result, the development and utilization of learning media is needed for fullfilling the demand of the new era of education. Schools, teachers, researchers and educational students are trying to develop the use of various technologies in learning process. In recent years, great positive changes have taken place and are taking place to equip higher and secondary special educational institutions with information technology, to improve the content of the education system, the forms and quality of its organization (Olimov & Mamurova, 2022).

One of the technology-based learning media that can be used by educators in the learning process is electronic module (e-module). E-Module is a module packaged in electronic or digital form that contains a variety of interactive media (ElAdli & Musawi, 2020). E-Module can be designed in various formats as needed by adding many features (Alshaya & Oyaid, 2017). E-module or electronic module is an independent study material presented in an electronic format such as a computer or android equipped with multimedia, systematically arranged into the smallest learning unit that aims to achieve learning goals (Wirawan et al., 2014). Learning using e-modules aims to learn independently and measure their abilities through learning outcomes so that learning is more effective in achieving

learning objectives (Kurniawan et al., 2020). The advantages of e-module includes; easily accessible (Abidin & Walida, 2019), can be designed with multiple media or multimedia (Suwatra et al., 2018), and greater interactivity (Boticki et al., 2019). The only disadvantage of e-module are the device and internet requirements.

Nature of Science education refers to the study of how science is a human initiative, how it interacts with society, what scientists do, how scientific knowledge is built up and exchanged, how it evolves, how it is used. It stresses the empirical nature and the different methods used in science. The goals of Nature of Science education are stated to be to help students evaluate scientific and pseudo scientific statements, to motivate them to study science and to better prepare them for a career in science or in a field that interacts with science (Bugingo et al., 2022). This study aims to analyze and describe trends in the research and development of electronic modules in science education.

2. METHODOLOGY

The research methods used in this study combine the literature review and bibliometric analysis conducted using Publish or Perish (PoP) and VOSViewer software. Using Publish or Perish (PoP) software, the literature search uses the keyword "Science E-module" based on Google Scholar in 2018-2023 (6 years including pandemic years). Analysis also covers aggregation and ranking, which are conducted to evaluate the academic output. The results of this search are sorted and stored in a Research Information Systems (RIS) format on a PoP.

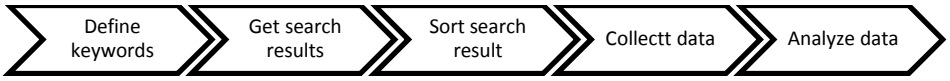

Figure 1. Five-Step Bibliometric Analysis Method (Haryandi et al., 2021)

Bibliometrics is a set of quantitative methods used to explore a research domain through the article metadata provided in bibliographic databases (Gutiérrez-Salcedo et al., 2018). The five-step bibliometric analysis method is adopted, shown in figure 1. On the VOSViewer sofware, the RIS-formatted data is reviewed by creating map. Then the analysis is processed by using the result from the VOSViewer. Co-occurrence is a quantitative analysis that uses the number of times a term will appear in more than one article in the database to construct the conceptual knowledge structure of a research domain and highlight its key areas (Aria & Cucurullo, 2017).

3. RESULT AND DISCUSSION

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The output of the Publish or Perish (PoP) search will display the result any keywords used by the author. The result obtained from searching with title 'Science E-Modules' is in Table 1.

Table 1. Search result about 'Science E-Module' 2018-2023

Metrics Data	Result
Query	Science e-module
Source	Google Scholar
Papers	83
Citation	521
Years	6 (2018-2023)
Cites/year	104.2
Cites/paper	6.28
Authors/Paper	2.72
h-index	7
g-index	21

Based on the result, 83 papers during period 2018-2023 about 'Science E-Modules' are obtained from Google Scholar. That period includes the pandemic year 2020 and 2021. The amount of citations indicates the impact of the journal. After sorting process, obatined the list based on the rank. Here are the data for the Top 10 articles about 'Science E-Modules', which can be seen in Table 2.

Table 2. Top 10 articles about 'Science E-Module' 2018-2023

Rank	Writer(s)	Year	Title	Journal	Result
1	V Serevina, I Astra, IJ Sari	2018	Development of E-Module Based on Problem Based Learning (PBL) on Heat and Temperature to Improve Student's Science Process Skill.	Turkish Online Journal of Education	The E-module based on Problem Based Learning (PBL) on the subject of heat and temperature is feasible to improve students' science process skill for high school students. The calculation of the n-gain test shows that the magnitude of the increase before and after students' learning..
2	D Darmaji, A Astalini, D Kurniawan, H Parasdila, I Irdianti, S Susbiyanto, K Kuswanto, M Ikhlas.	2019	E-module Based Problem Solving in Basic Physics Practicum for Science Process Skills	International Association of Online Engineering	Problem solving based physics practicum e-module uses the kvisoft application. The use of e-modules is more interesting in conducting basic physics practicum activities. This also makes students' science process skills in the good category.
3	A Pratono, SS Sumarti, N Wijayati	2018	Contribution of Assisted Inquiry Model of E-Module to Students Science Process Skill	Journal of Innovative Science Education	The application of guided inquiry assisted e-module contributes to the students' science process skills.
4	A Purwanto, M Nurjayadi, R Suluya, IZ Ichsan	2020	EM-SETS: An Integrated E-module of Environmental Education and Technology in Natural Science Learning	International Journal of Advanced Science and Technology	EM-SETS modules on electrochemical topics for Vocational Schools developed are already appropriate to be used as interactive and interesting teaching materials and can help students to learn independently.
5	A Feri, Z Zulherman	2021	Development of Nearpod-Based E-Module on Science Material "Energy And Its	International Journal of Education and Learning	E-nearpod-based modules have excellent quality, both in material aspects and media aspects. Using nearpod-based e modules on science

Rank	Writer(s)	Year	Title	Journal	Result
			Changes" to Improve Elementary School Student Learning Achievement		materials "energy and change" is feasible for grade IV elementary school students.
6	A Yunita, S Suyidno, S Syahmani	2021	The validity of science e-module based on the authentic problem	Journal of Physics : Conf. Ser. 1760 012037	E-modules with authentic problems can be recommended to use in online learning, especially in coronavirus pandemic, to improve student's scientific literacy and self-efficacy. Students can be more independent in learning science.
7	RC Katauhi, W Widodo, DAP Sari	2022	Implementation of the science e-module based on guided inquiry with the flipped classroom strategy to improve students science process skills	Jurnal Pijar MIPA	Science e-module based on guided inquiry with the flipped classroom strategy can effectively improve junior high school students' science process skills.
8	A Nurramadhani, SS Lathifah, I Permana	2020	Students' generated questions quality by developing STEM-based e-module in science learning	Scientiae Educatia: Jurnal Pendidikan Sains	The implementation of developed STEM-based E-Modules is achievable. Students' generated questions quality is slightly developed, which means that it is attained at the beginning of the open question category as higher-level quality.
9	BA Hutomo, S Saptono, B Subali	2022	Development of E-module Based on Science, Technology, Engineering, and Mathematics (STEM) To Improve Science Literacy of Junior High School Students	Journal of Innovative Science Education	The use of the developed Science, Technology, Engineering and Mathematical (STEM)-based e-module is feasible to be used as an alternative learning resource for substance pressure material in science learning.
10	A Fahlevi	2021	Practicality E-Module of Vibration in	Pillar Of Physics Education	The average value of e-module practicality which was developed according to

Rank	Writer(s)	Year	Title	Journal	Result
			Everyday Life on Online Learning to Improve Science Process Skills of Grade X High School Students		the teacher, which was 94.5 in the very good category and the average value of e-module practicality according to the students got a value of 90.5 in very good category.

Beside that, the sorting based on year is also processed with the result shown in Table 3 and Figure 2. The number of publications slowly increased between 2018 and 2020. Then, it witnessed a drastic increase at a much faster pace, from 2020 to 2022, in the pandemic year. This growth indicates that researchers were encouraged to develop e-module during the online learning system.

Table 3. Amount of article about 'Science E-Module' 2018-2023

Year	Amount	Percentage
2018	7	8,4
2019	6	7,2
2020	8	9,6
2021	18	21,7
2022	30	36,1
2023*	14	16,9
Total	83	100

*The year 2023 is still on going.

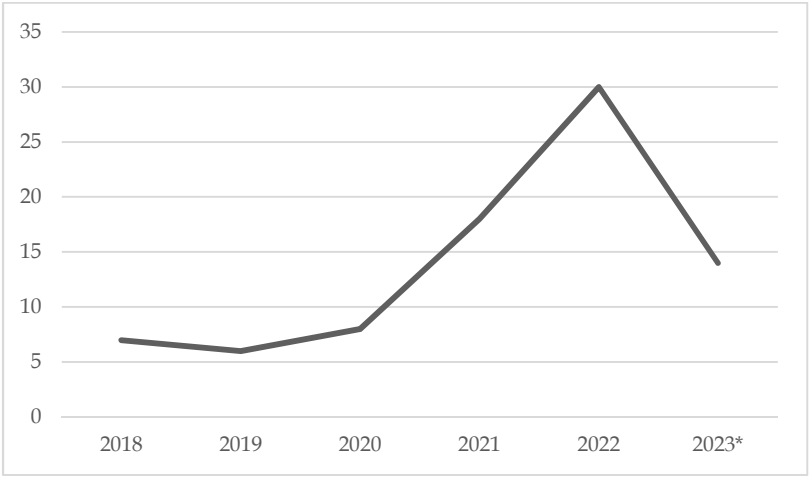

Figure 2. Graph of amount of article about 'Science E-Module' 2018-2023

Then, using VOSviewer co-occurrence analysis, the author keywords are arranged in 11 clusters in the network visualization map in Figure 3. This conducted cluster analysis of keywords in research articles can help categorize research trends, study their evolution over time, and uncover the interconnection between them (Mohamed & Marzouk, 2023). Each node represents a keyword, and the node size is determined by the number of occurrences of its associated keyword. In addition, each node is assigned a color that corresponds to its cluster. Clusters are formed of keywords that appear together in similar research or sometimes in the same discipline in the case of multidisciplinary research. Such a map facilitates understanding the research landscape and identifying terms used in the research of science e-module. It is worth noting that there is a lot of overlap between the clusters, as

the network visualisation map shows. In Figure 3, it can be seen that there are 8 clusters marked with 8 different colours. The recapitulation oh the items in each cluster is presented in Table 4.

Table 4. The recapitulation oh the items in each cluster

Cluster	Amount	Items
1	14	analysis; e-module development; feasibility; improvement; inquiry; practically; science e-module; science literacy; science subject; scientific literacy; student; student science literacy; test; validity
2	10	e-module; implementation; integrated science; integrated science e-module; interactive e-module; joyful learning; picture; science learning; study; theme
3	9	development e-module; effect; engineering; islamic literacy; mathematics; physics e-module; science; STEM; technology
4	7	data; effectiveness; learners science literacy; static fluid material; STM; students science; wetland environment
5	7	e-module; integrated STEM; research; science process; science process skill; students science process skill; use
6	5	form; heat; PBL; problem; temperature
7	5	development; environment; product; project; set
8	1	Local wisdom

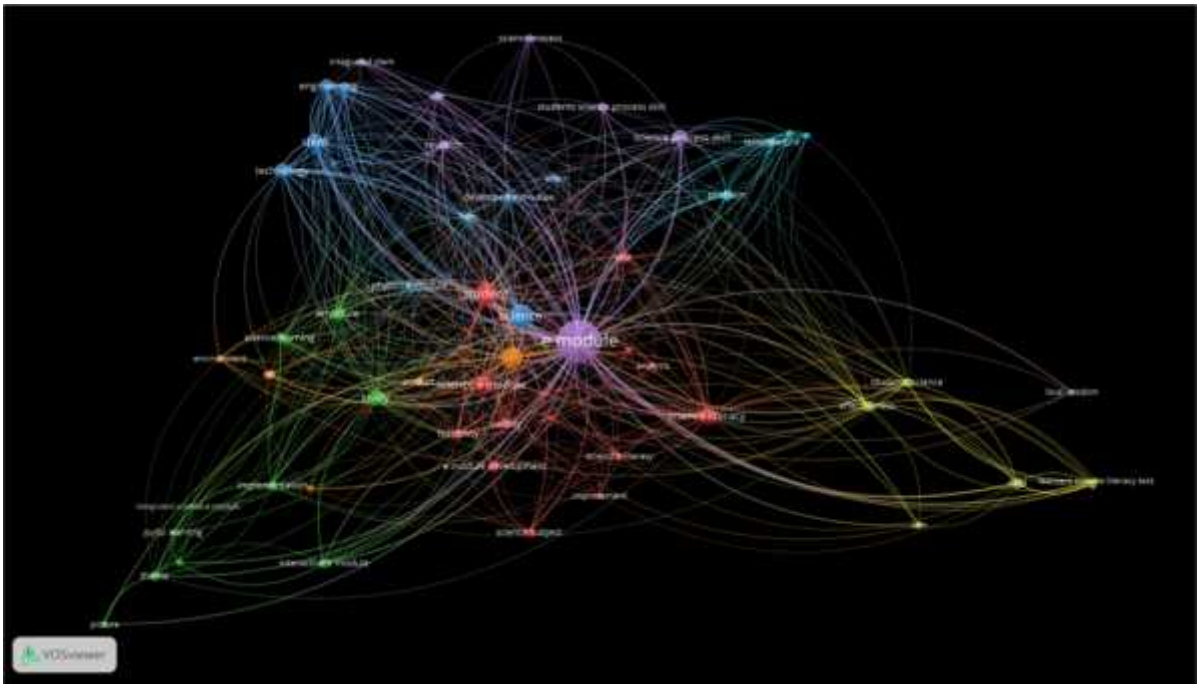

Figure 3. Network Visualization on Google Scholar Database 2018-2023

Based on the network visualitation and cluster recapitulation, science e-module has connection with STEM (Science, Technology, Art, Mathematics) and PBL (Problem Based Learning). Science e-module also links with many fields like physics, technology, mathematics, environment, and engineering. Science e-module connects with some skills like science process skill and science literacy. The research of science e-module also mentions joyful learning, interactive e-module and even local wisdom. This result shows that the researchs and developments of science e-module stand along other variables like learning models, fields, and skills. The bibliometric analysis results indicate that the most topics to address regarding the science e-module are those related to STEM (Science,

Technology, Engineering and Mathematics) and science process skill. STEM and its parts are mentioned in cluster 3, 4, and 5. The science process skill is mentioned three times in cluster 5. It is supported that almost of top 10 articles about science e-module discuss about science process skill.

Each cluster contained in Figure 4 shows a visualization of the density of the keywords used by the author. Density will be indicated by the intensity of the colour in the image. The lighter the colour, the more often the keyword is used by the author. The STEM and science process skill have the lighter colour compared to the other keywords. This result is in line with the network visualisation analysis and the result of top 10 articles about science e-module.

Figure 5 will analyse how to spread the article's focus at any time. This way, you can see what the latest trends are. The STEM and science process skill show the different result. The STEM with green colour indicates that the research about science e-modul connected with STEM is still relevant, but need modification for novelty. On the contrary, science process skill with purple colour show that the related research trends are already in the past.

The picture shows that some of the newest keywords linked with science e-module research are validity, feasibility, scientifc literacy and local wisdom. This result indicates that e-modul research will develop in the context of local wisdom and scientific literacy based on the validity and feasibility. The STEM connected with local wisdom can be a new trend. The research about science e-module will still move forward in the future. This is good for further development. So it is still recommended to innovate science e-modules with more variables that will give much variaton for science e-module development.

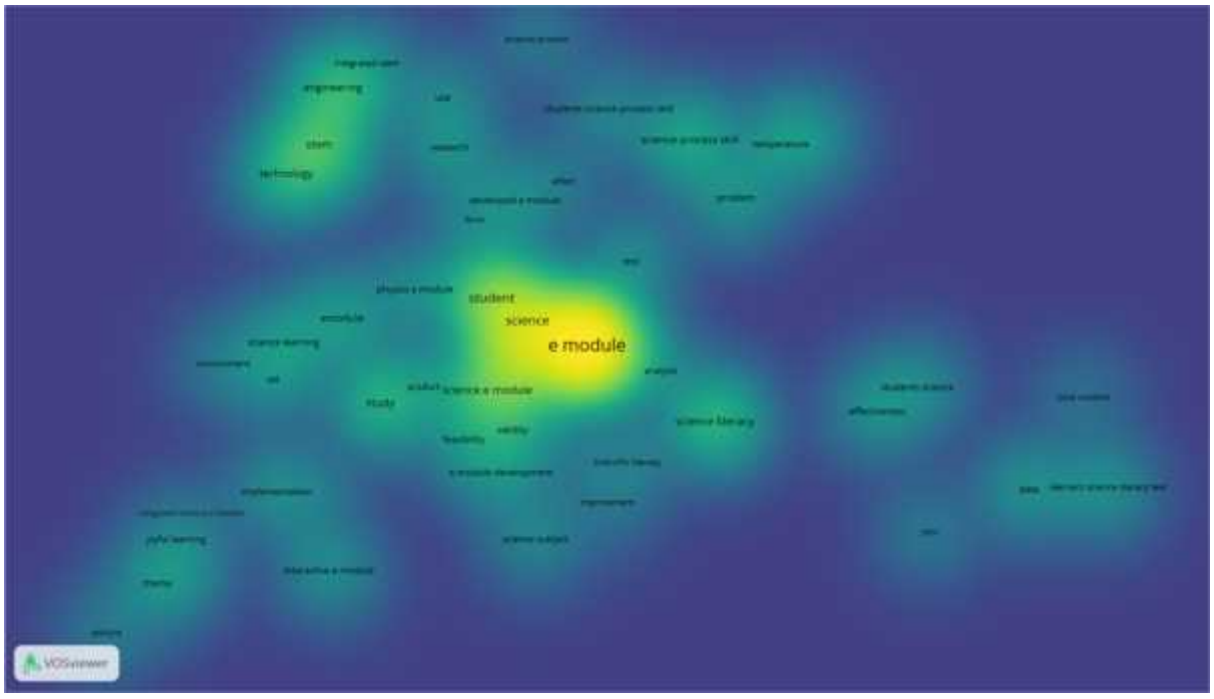

Figure 4. Density Visualization on Google Scholar Database 2018-2023

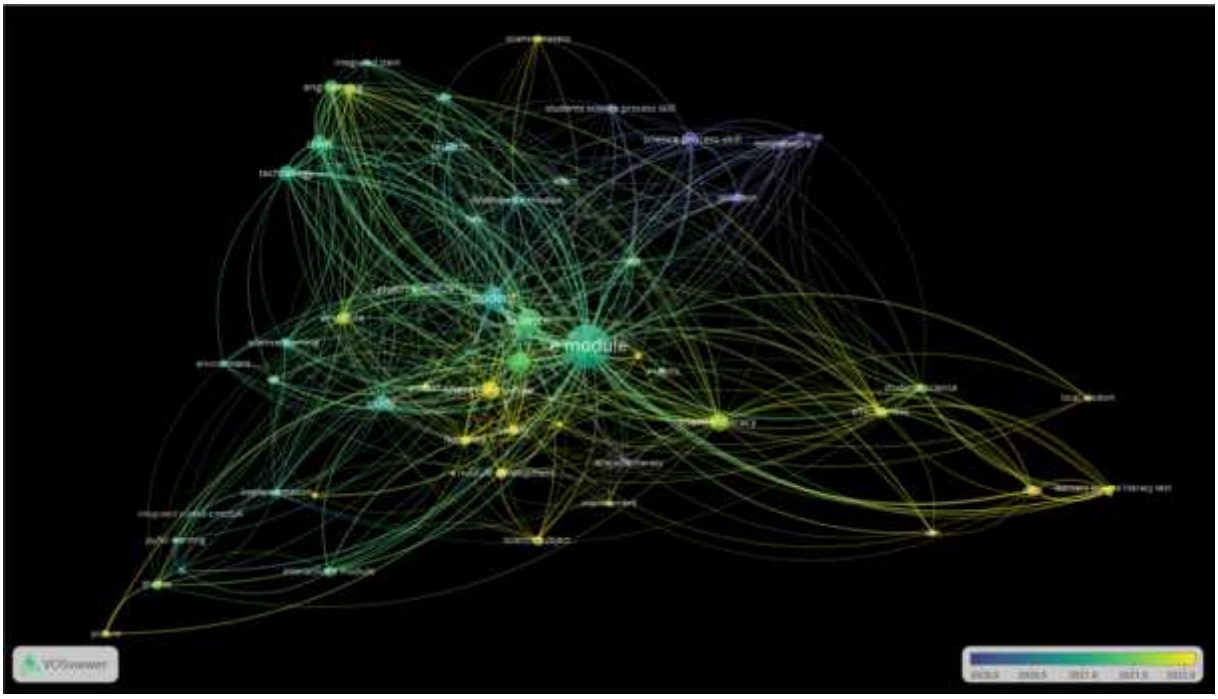

Figure 5. Overlay Visualization on Google Scholar Database 2018-2023

4. CONCLUSION

Based on the results of literature review and bibliometric analysis, it can be concluded that articles about science e-module in the period 2018-2023 witnessed a drastic increase from 2020 to 2022, which confirms that science e-module is a promising and prevalent research domain. The bibliometric analysis results indicate that the most topics to address regarding the science e-module are those related to STEM (Science, Technology, Engineering and Mathematics) and science process skill. In further research, science e-modules can be developed with other topics that have not been discussed before or by combining several topics into a new topic such as ethno-STEM to improve scientific literacy.

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