STEM Education Implementation in Indonesia: A Scoping Review
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Abstract
In Indonesia, STEM education has been implemented in the learning process since 2014. The number of researches on the implementation of STEM education are increasing from year to year. Therefore, this research was conducted to map the all articles published online with the theme of STEM education implementation in Indonesia. The scoping review was carried out following the framework from Arksey & O'Malley (2005), with the following steps: (1) formulating research questions, (2) exploring research results on Google Scholar database from 2015-2020 with the keyword “implementation” + “STEM education” + “Indonesia”, (3) sorting the collected articles with predetermined criteria and selecting them according to the PRISMA model, (4) discussion, and (5) conclusion. Found 597 articles that match to these keywords and 154 articles that meet the criteria as research data. The results showed that the STEM education is implemented as a learning strategy and approach, integrated with other learning models, used as a learning assessment, and developed into teaching materials, modules, and learning media. Additionally, teachers implement STEM to improve entrepreneurship skills, learning motivation, and various 21st-century skills in their students. Furthermore, research on STEM has been conducted in 19 provinces in Indonesia, which are dominated by West Java and East Java provinces. Beside that, the STEM education has been studied at all levels of education and high school is the most widely used research subject and STEM education has grown in small units and has proven to be capable of developing many student skills. The implementation of STEM education can be a trigger for renewal in the world of education.

Keywords: scoping review, STEM education, Indonesia

INTRODUCTION
The issue of science, technology, engineering, and mathematics (STEM) education has developed very rapidly in all countries. The comprehensive integration of the four disciplines provides great potential to improve the quality of learning. STEM can encourage students to be skilled in designing, developing, and utilizing technology, as well as applying integrated knowledge to solve problems (Kapila, 2014). Therefore, STEM education is very interesting for researchers and teachers.

Teachers play an important role in the implementation of STEM (McDonald, 2016). In science learning, STEM is an alternative learning model that is able to build a capable and skilled 21st century generation (Permanasari, 2016) and also meet the challenges of industry 4.0. In addition, teachers can use STEM education as a learning strategy, learning approach,
learning method, assessment, learning media, teaching materials, and textbooks (Farwati et al., 2021).

In Indonesia, STEM Education has been started to be researched in 2014. This information was obtained from the Google Scholar database. The first publication found was the thesis of a chemical education student in Aceh, Nanggroe Aceh Darussalam, Indonesia. In 2014 there was only one publication in the form of the thesis. However, as time goes on, more and more reviews about STEM are being netted by researchers in Indonesia. There are 3,680 articles on Google Scholar with the keyword "STEM education" Indonesia and 597 articles with the keyword implementation of "STEM education" Indonesia for 2015-2020. Therefore, it is necessary to map out research on the implementation of STEM education in Indonesia.

Ananda & Salamah (2021) have mapped national articles on the effect of STEM implementation on students’ critical thinking in Indonesia. In addition, a review of the effect size of the use of STEM-based teaching materials in science (Izzah et al., 2021) and learning ecology (Santosa et al., 2021) has been reported. However, previous studies only focus on examining one skill and one teaching media for the elementary-high school level, not covering all levels of education units and all STEM research themes that have been implemented in Indonesia.

Based on this background, the purpose of this study is to map all research themes related to the implementation of STEM education in Indonesia in the science field and the scientific clumps of science from 2015-2020, starting from elementary school to tertiary education levels. In addition, this study also conducted data collection on research locations to be able to see the distribution of research on STEM implementation throughout Indonesia. The results of this study are expected to describe the development of research on STEM implementation from year to year, the education level of the participants involved, the (province) research location, and all research themes on STEM education in Indonesia that have been carried out. This information can be used as consideration for making policies related to STEM in Indonesia. In addition, the report from this study can also show the extent of efforts to improve the quality of education in Indonesia with STEM education.

**METHOD**

This study is a scoping review using Arksey and O’Malley’s five-stage framework, including identifying research questions, identifying relevant studies, study selection, charting the data, summarizing and reporting the results were utilized in this review (Arksey & O’Malley, 2005). The stages of identifying research questions, identifying relevant studies, and
study selection will be presented in the method section, but the stages of charting the data, summarizing, and reporting the results will be presented in the result and discussion section.

**Identifying Research Questions**

This review was focused on exploration about three aspects, including research theme, research participants, and location (province in Indonesia) STEM Education was implemented. The following research questions are submitted to guide the research to capture literature that is in line with the focus of this study:

1. What are the research themes of STEM Education implemented in Indonesia?
2. Who are the research participants involved in research on the implementation of STEM Education in Indonesia?
3. In which provinces in Indonesia is STEM Education research conducted?

**Identifying Relevant Studies**

The second step is identifying relevant studies. Keyword “implementation” + “STEM Education” + “Indonesia” is selected to capture literature regarding the implementation of STEM Education in Indonesia. The reason for selecting ‘STEM Education + Indonesia STEM Education + Indonesia’ as a search term was to reach out to as many relevant studies as possible. Afterward, inclusion and exclusion criteria were developed to get insights about the aspect that can be included to summarize the selected studies. Table 1 shows the inclusion and exclusion criteria.

**Table 1. Inclusion and exclusion criteria**

| Criteria            | Inclusion                                                                 | Exclusion                                      |
|---------------------|---------------------------------------------------------------------------|------------------------------------------------|
| Time Period         | a. Quantitative and development research                                  | a. Qualitative research                        |
| Focus of Study      | b. Implemented on science education, chemistry education, biology education, and physics education | b. Implemented on outside science education, chemistry education, biology education, and physics education |
|                     | c. Study location in Indonesia                                            | c. Study location in other countries           |
|                     | d. Published in journals and conference proceedings                       |                                                |
| Participant         | Students in formal education: Elementary School, Junior High School, Senior High School, Vocational School, and undergraduate School focus on science education. | Student in non-formal education or informal participant |

**Study Selection**

The article selection process on this study followed the PRISMA model in the form of a four-phase flow diagram, including identification, screening, eligibility, and inclusion (Moher, et al., 2009). The stages of the article selection process can be seen in Figure 1.
Figure 1. PRISMA flow diagram for article selection

Figure 1 shows the fact that most of the articles were irrelevant with inclusion criteria. Studies about the implementation of STEM Education for another subject are excluded, i.e. career interest in the field of STEM, didactic reduction, systematic literature review (SLR), and teacher training. Moreover, the preview of thesis and dissertations are also excluded.

RESULTS AND DISCUSSION

Charting the Data

The next step in this scoping review was charting the selected articles. The final articles included in review as many as 154 articles related to implementation of STEM Education in Indonesia. After each study is perceived to be included in the inclusion criteria, summaries are developed for each article with several variables, including the author(s), year, the theme of research, participant, and location. Table 2 shows descriptive information of reviewed articles.

| Research Theme | Educational Level | Research Location | Authors |
|----------------|-------------------|-------------------|---------|
| Assessment     | Elementary School | West Java         | Hamdu et al. (2019), Nurlenasari et al. (2019), Kurniasih et al. (2020), Rahmat et al. (2020), Syadiah & Hamdu (2020) |
|                | Junior High School| East Java         | Suprapto (2016) |
|                | Senior High School| DI Yogyakarta     | Supahar & Nurcahyanto (2015) |
| Research Theme          | Educational Level | Research Location       | Authors                                      |
|------------------------|-------------------|-------------------------|----------------------------------------------|
| teaching materials     | Vocational High School | DKI Jakarta, West Java | Putri & Istiyono (2017)                      |
|                        | Undergraduate     | East Java, West Java    | Candraningrum & Dhewy (2016)                 |
|                        |                   |                         | Septiani & Rustaman (2017)                   |
|                        |                   |                         | Mayasari et al. (2016)                      |
|                        |                   |                         | Nanang et al. (2018)                        |
|                        | Elementary School | Bangka Belitung, DI Yogyakarta, West Java | Yuanita & Kurnia (2019)                      |
|                        |                   |                         | Erviana & Asmara (2019)                     |
|                        |                   |                         | Hamdu & Rostiana (2020)                     |
|                        |                   |                         | Nisa & Nugroho (2020)                       |
|                        | Junior High School | West Java, East Java    | Rusyati et al. (2019)                       |
|                        |                   |                         | Sukmagati et al. (2019)                     |
|                        | Senior High School | Central Java, East Java | Pangesti et al. (2017)                       |
|                        |                   |                         | Utomo et al. (2018)                         |
|                        |                   |                         | Ningtyas et al. (2019)                      |
|                        |                   |                         | Riau                                          |
|                        |                   |                         | Azura & Octarya (2020)                      |
|                        |                   |                         | Supriyati et al. (2020)                     |
|                        | Undergraduate School | South Sumatra           | Negara et al. (2017), Rachmawati et al. (2017), Riandry et al. (2017) |
| worksheets             | Elementary School | West Java, West Nusa Tenggara | Fatimah et al. (2019)                       |
|                        |                   |                         | Haifaturrahmah et al. (2020)                 |
|                        | Junior High School | East Java, Central Java | Fitriyah & Wardana (2019)                   |
|                        |                   |                         | Sukmagati et al. (2020)                     |
|                        | Senior High School | Nanggroe Aceh Darussalam | Rahmiza et al. (2015)                       |
| Learning Media         | Elementary School | DI Yogyakarta, Nanggroe Aceh Darussalam | Erviana (2019)                             |
|                        |                   |                         | Setiawati et al. (2020)                     |
|                        |                   | Lampung, West Java      | Saputra et al. (2020)                       |
|                        |                   |                         | Firdaus & Hamdu (2020)                      |
|                        |                   |                         | Sakinah et al. (2020)                       |
|                        | Junior High School | West Java, Lampung      | Maula & Fatmawati (2020)                    |
|                        |                   |                         | Afriana et al. (2016)                       |
|                        |                   |                         | Sudarsono et al. (2019)                     |
|                        | Senior High School | Central Java, Central Java | Sari & Apriyantika (2020)                   |
|                        | Undergraduate School | Central Java, East Java, Lampung, Central Java, East Nusa Tenggara | Santos & Mosik (2019)                       |
|                        |                   |                         | Rokhim et al. (2020), Widarti et al. (2020) |
|                        |                   |                         | Iqbal et al. (2019)                         |
|                        |                   |                         | Susanti et al. (2018)                       |
|                        |                   |                         | Dewati et al. (2019)                        |
|                        |                   |                         | Hidayati et al. (2019)                      |
|                        |                   |                         | Wahyu et al. (2020)                         |
| Research Theme | Educational Level | Research Location | Authors |
|----------------|-------------------|-------------------|---------|
| module         | Junior High School| East Java         | Basuki et al. (2018), Alfika et al. (2019), Almuharomah et al. (2019), Safitri et al. (2019), Septaria et al. (2020) |
|                | Senior High School | East Java         | Sampurno et al. (2015) |
|                |                   | Riau              | Syahirah et al. (2020) |
|                |                   | South Sumatra     | Oktaviani et al. (2020) |
|                | Undergraduate     | Nanggroe Aceh     | Sakdiah et al. (2020) |
| School         |                   | Darussalam        |                     |
|                |                   | South Sumatra     |                     |
|                | Model/Strategy/   | Nanggroe Aceh     | Zuriyatina et al. (2020) |
| Approach       | Elementary School | Darussalam        | Siregar et al. (2019) |
|                |                   | West Java         | Firdaus & Rahayu (2019) |
|                |                   | Central Java      | Gandi et al. (2019), Mufidah et al. (2019), Septine et al. (2019) |
|                |                   | Lampung           | Abdurrahman et al. (2019) |
|                |                   | Central Java      | Akhmad et al. (2020), Baihaqi et al. (2020), Dywan & Airlanda (2020), Ridlo et al. (2020), Twiningsih (2020) |
|                | Junior High School| West Borneo       | Priyani & Nawawi (2020) |
|                |                   | West Java         | Sumarwa et al. (2015), Ismail et al. (2016), Khaeriningtyas et al. (2016), Agustina et al. (2017), Fitriani et al. (2017), Tati et al. (2017), Han & Suwarma (2018), Haryanti & Suwarma (2018), Liiawati et al. (2018), Nuraziza & Suwarma (2018) |
|                |                   | East Java         | Sugiarti et al. (2018) |
|                |                   | Central Java      | Lestari et al. (2018) |
|                |                   | West Java         | Mu’minah & Aripin (2019), Sulistiowati et al. (2019) |
|                |                   | West Nusa Tenggara| Hera & Lamanepa (2019) |
|                |                   | East Java         | Primasari et al. (2019) |
|                |                   | Central Java      | Lathif et al. (2019) |
|                |                   | Nanggroe Aceh     | Julia et al. (2020) |
|                |                   | Darussalam        |                     |
|                |                   | DKI Jakarta       | Haryanti et al. (2020) |
|                |                   | West Java         | Heryanti (2020), Rustaman (2020) |
|                | Senior High School| East Java         | Indriyawanti et al. (2020) |
|                |                   | Nanggroe Aceh     | Adli et al. (2015) |
|                |                   | Darussalam        |                     |
|                |                   | East Java         | Arie et al. (2015) |
|                |                   | West Java         | Kaniawati & Suryadi (2016), Dewi et al. (2018) |
|                |                   | East Java         | Rivai et al. (2018) |
| Research Theme | Educational Level | Research Location | Authors |
|----------------|-------------------|-------------------|---------|
| DI Yogyakarta  | Vocational High School | Wisudawati (2018) |
| Bali           |                   | Wibowo (2018)    |
| Nanggroe Aceh  |                   | Munandar et al. (2019) |
| Darussalam     |                   | Gevi (2019)      |
| Sumatra Barat  |                   | Rosidin et al. (2019) |
| Lampung        |                   | Sagala et al. (2019) |
| DKI Jakarta    |                   | Rahmawati et al. (2019) |
| West Java      |                   | Aninda et al. (2019), Cholisoh (2019), Fikri et al. (2019), Hanif et al. (2019) |
| Central Java   |                   | Aryani et al. (2019), Yuliandi et al. (2019) |
| DI Yogyakarta  |                   | Triastuti (2019)  |
| East Java      |                   | Ananda & Dasna (2019), Hudha et al. (2019), Maulidi et al. (2019), Rizkihati et al. (2019), Sumardiana et al. (2019), Sutoyo et al. (2019) |
| West Nusa Tenggara |                   | Ardianti et al. (2019), Musyasarar et al. (2019), Pranita et al. (2019) |
| South Borneo   |                   | Rahman et al. (2019) |
| Lampung        |                   | Syafei et al. (2020) |
| East Java      |                   | Darmawan (2020)   |
| East Java      |                   | Hasbullah et al. (2020), Khotimah et al. (2020), Lukitawanti et al. (2020), Paramita et al. (2020), Putri et al. (2020), Roja et al. (2020) |
| Central Java   |                   | Ariyatun & Oktavianelis (2020) |
| Gorontalo      |                   | Nurfadilah & Siswanto (2020) |
| Lampung        |                   | Utina (2020)      |
| East Java      |                   | Saputri et al. (2020) |
| East Java      |                   | Agustin (2020)    |
| West Nusa Tenggara |                   | Devi et al. (2020) |
| Vocational High School |                   | Ardianti et al. (2020) |
| DI Yogyakarta  |                   | Safitri & Priyambodo (2016) |
| West Java      |                   | Apriyani et al. (2019) |
| Bali           |                   | Sadiatmika (2020) |
| Undergraduate School |                   | Setiawaty et al. (2018) |
| Nanggroe Aceh  |                   |                     |
| Darussalam     |                   |                     |
| Central Java   |                   | Wijayanti & Fajriyah (2018) |
| South Sumatra  |                   | Farwati et al. (2018) |
| West Java      |                   | Windu et al. (2019) |
| West Java      |                   | Ardianto et al. (2019) |
| South Sulawesi |                   | Agustina et al. (2019) |
| Gorontalo      |                   | Anita et al. (2019) |
| Papua          |                   | Sunardi & Hasanuddin (2019) |
| Papu           |                   | Yusuf & Widyaningsih (2019) |
| Lesson Plan | Undergraduate School | Research Theme | Educational Level | Research Location | Authors                  |
|-------------|----------------------|----------------|-------------------|-------------------|-------------------------|
|             |                      | Nanggro Aceh   | Nanggro Aceh Darussalam | Sari et al. (2020) |
|             |                      | West Java     | West Java | Nurkanti et al. (2020) |
|             |                      | East Java     | East Java | Meishanti (2020) |
|             |                      | DI Yogyakarta | DI Yogyakarta | Pratama et al. (2020) |
|             |                      | DKI Jakarta   | DKI Jakarta | Pujiati (2020) |
|             |                      | East Java     | East Java | Widiyanti & Mizan (2020) |

**Summarizing and Reporting Findings**

The last step of Arksey and O’Malley’s five-stage framework is summarizing and reporting findings. What is meant by the implementation of STEM education in this study is the result of applying STEM education in learning. The application of STEM education can be in strategies, approaches, models, or learning methods. In addition, the application of STEM education can also be used as teaching materials, modules, student worksheets, learning media, and learning assessments (Farwati et al., 2021). Therefore, the implementation of STEM education is synonymous with quantitative research and development.

In 2014 only one publication was found on the implementation of STEM education in Indonesia. The publication is in the form of a repository of thesis for Chemistry education students in Aceh, Nanggro Aceh Darussalam. No other articles related to STEM education were found that were published on Google Scholar, and this study took data on Google Scholar for the 2015-2020 period.

From 2015 the number of studies on STEM implementation in education continued to increase, until there was a significant increase in 2019. The number of studies on the implementation of STEM education in 2019 jumped 2.5 times from 2018. This data shows the enthusiasm of teachers and researchers related to STEM education. Nevertheless, the overall number of studies on the implementation of STEM education in Indonesia is still quite apprehensive.

Netted 154 articles in the last six years researching the implementation of STEM education. Thus, only about 26 studies per year are conducted on STEM implementation. This number is relatively minimal because it is compared to the number of teachers and researchers in the science field and the many science clusters in Indonesia. These findings should be taken into consideration for: (1) Increasing the socialization of STEM education to students and teachers of Science, Chemistry, Biology, and Physics; (2) Encouraging and facilitating students and teachers of science and science clusters to conduct research related to STEM
implementation; (3) Establish a discussion forum with structured activities related to STEM education in every province in Indonesia. This way is expected to increase the interest of researchers in the implementation of STEM education.

![Trends in STEM Education Research in Indonesia 2015-2020](image)

**Figure 2. Trends in STEM Education Research in Indonesia 2015-2020**

The implementation of STEM education in 2019 and 2020 accounted for 74.1% of the overall data from 2015 to 2020, as shown in Figure 2. STEM research trends experienced a dramatic increase in 2019 and 2020, but the number of studies in 2020 less (1.3%) compared to 2019. The decrease in the number of studies is thought to be influenced by the Covid-19 pandemic. This condition has an impact on the education process in various countries in the world, including in Indonesia (Abidah et al., 2020; Areba, 2020; Franchi, 2020; Iyer et al., 2020; Nambar, 2020; Popyk, 2020; Putri et al., 2020; Rizun & Strzelecki, 2020; Sari et al.).

The government enforces a policy of studying from home during the Covid-19 pandemic for high school levels. Likewise for higher education levels are based on the circular of the Ministry of Research, Technology and Higher Education No. 1 of 2020, which urges universities to conduct learning remotely or online. This policy, of course, also has an impact on research on the implementation of STEM education because STEM-based learning is commonly done through face-to-face learning in schools. Meanwhile, during the Covid-19 pandemic, learning is carried out online. Online learning is carried out using zoom, jizti, google meet, Webex applications, and the teacher makes short explanatory videos that can be shared.
via WhatsApp and YouTube media, where the video recordings can be used repeatedly (Pujiasih, 2020). In addition, Edmodo, Moodle, email, study houses, and Schoology applications can also be used (Sari, 2020).

The decline in STEM research trends in 2020 indicates the need to revive STEM research. Various aspects of STEM skills need to be developed in students in order to produce quality future generations and be able to compete globally. STEM research in the pandemic era can be integrated with online learning through the use of augmented reality (AR) and virtual reality (VR) technology. AR can be applied in distance learning (Ahied et al., 2020; Altinpulluk et al., 2020; Faregh & Sisi, 2020) as well as VR (Fauville et al., 2021; Georgieva-Tsaneva & Serbezoiva, 2020; Harfouche & Nakhle, 2020; McFaul & FitzGerald, 2020). Several studies have also suggested that AR and VR technology can be used in STEM learning (Christopoulos et al., 2020; Nordin et al., 2020; Petrov & Atanasova, 2020; Yildirim et al., 2020; Wahyu et al., 2020). Thus, it is necessary to train AR and VR skills for both teachers and prospective teachers so that they can continue to carry out STEM learning during the COVID-19 pandemic in order to create quality education. Education is the most important basis to face the era of society 5.0, which becomes a serious challenge if human resources are not well prepared and mature for the golden generation as the successor of the nation's progress (Pujiasih, 2020).

Figure 3. Distribution of STEM Implementation Research Locations in Learning

The distribution of STEM research is still concentrated in only two provinces: West Java and East Java, reaching 49.3% as shown in Figure 3. There are 44% of provinces that are not recorded as implementing STEM education in learning. This data shows that there is no equal distribution of information about STEM education, and there is no uniformity in the spirit
of reform in education from teachers in all provinces in Indonesia. Thus, more effort is needed for provinces that are not familiar with STEM education.

Efforts that can be made to disseminate information about STEM are to conduct socialization and mentoring about STEM, as has been done by lecturers in Bali who carried out socialization through community partnership programs about making learning implementation plans by implementing STEM. These activities are poured into writing in the form of a journal. The benefit of these activities is that teachers are able to make learning implementation plans by implementing STEM (Sukendra et al., 2020). Thus, socialization and assistance related to STEM have the potential to be carried out in Indonesia. In addition, direction from universities is also needed for their students to conduct research on STEM education in other areas so that they are not concentrated in Java. Universities can also do community service in the form of training activities for teachers outside the island of Java for the purpose of this equity. Another alternative that can be done is to raise the issue of local wisdom to be integrated into STEM education (Almuharomah et al., 2019; Prasadi et al., 2020; Priyani & Nawawi, 2020). Indonesia has cultural diversity. Each region in Indonesia has its own cultural characteristics. This uniqueness becomes the potential in bringing up STEM education research ideas that are integrated with local wisdom issues for each region. It is hoped that the distribution of STEM education research in Indonesia is more evenly distributed.

Figure 4. Implementation of STEM Learning Research Based on Participant Education Unit Level.

Figure 4 shows that research on STEM implementation at the high school level dominates with a percentage of 42.2% compared to other education unit levels. This dominant number indicates a need to socialize more massive STEM learning at other levels of education. There are universities with science study programs and/or science clusters in every province in Indonesia. In addition, there are also teachers who teach science and science clusters at the
elementary, junior high, and high school/vocational schools throughout Indonesia. Socialization about STEM education can be done through seminars organized by student associations at the university level by involving students and teachers in the local province. The more people who do research related to STEM, the more new ideas related to STEM itself will appear. This will trigger more varied STEM research themes at the education unit level. In addition, support from the government is also needed. However, there have been many STEM training carried out by the Ministry of Education and Culture for teachers and launched a pilot school program that implements STEM learning (Aceh, 2021; Atik, 2018; Ministry of Education and Culture, 2020; PPPPTK & PLB, 2020). However, the Ministry of Education and Culture is also expected to create a collaborative program with university associations that have education study programs to map the direction of STEM education in Indonesia, given that the goal of STEM education is to instill 21st-century skills so that it is important to do it at all levels of education.

In 2015-2020 research on STEM-based learning strategies/approaches/models is very dominantly carried out by researchers in Indonesia, as shown in Figure 5. The research themes are found every year and starting in 2019. This research theme has been carried out at all levels of education. Whereas in previous years, the research theme only involved students at the junior high and high school levels. Overall, the theme of this study mostly involved students at the high school level as participants.
There are 5 other research themes that can be mapped from the publication of STEM implementation in Indonesia in 2015-2020, as presented in Figure 5. These various research themes were carried out to hone a series of skills needed by students, such as literacy (Sampurno, 2015; Afriana et al., 2016; Tati et al., 2017; Farwati et al., 2018; Anita et al., 2019), entrepreneurial ability (Adlim et al., 2015), and so on. Broadly speaking, the implementation of STEM in learning can improve the 21st-century skills of students (Permanasari, 2016; Farwati et al., 2021). These skills are needed by students to be able to play an active role while in the community. Therefore, STEM education should be used by all teachers, especially from the elementary school level. However, in the last six years, the implementation of STEM has involved the most participants at the high school level, reaching 42%. Thus, strong stimulation is needed so that other education unit-level teachers are interested in innovating by implementing STEM in classroom learning.

CONCLUSION

The peak of the increase in the number of research on the implementation of STEM education in Indonesia occurred in 2019. However, the Covid-19 pandemic resulted in a decrease in the number of STEM implementations in 2020, but not significantly. In 2015-2020, the implementation of STEM education was most widely used as a strategy/approach/learning model. The most frequently involved participants were high school students. Researchers from the provinces of West Java and East Java are the most active in conducting research on STEM implementation in the last six years. STEM-based learning has the potential to improve students' 21st-century skills. Therefore, the implementation of STEM education needs to be carried out evenly at all levels of education units and in all provinces in Indonesia. Stimulation and assistance to students and teachers are needed so that STEM education can touch all lines. Activities such as STEM-related competitions, STEM-based product exhibitions, and special research funds related to STEM, and training on the use of AR and VR for STEM-based learning during a pandemic can be alternatives to increase interest in STEM research in Indonesia. The active role of the government and researchers is needed so that the implementation of STEM in Indonesia can be carried out evenly at all levels of education units and all provinces in Indonesia.

SUGGESTIONS

The data source used in this study is the Google Scholar database, so it is necessary to conduct similar research on other databases such as Scopus, ERIC, or the web of science.
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