Technology integration for SDGs-oriented social science education: A bibliometric perspective

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Abstract. Research to analyze the potential for technology integration in international database education (Scopus). The research used is quantitative descriptive research with bibliometric analysis conducted using the Scopus database with an evaluation of the development of science using statistical data. The trend of technology integration research for SDGs-oriented social science education over the past 5 years has continued to increase every year. A total of 371 documents were obtained with the most types of sources in this study being journals with 218 article publications and 71 books. The novelty of the study found that AI has a strong influence on achieving the SDGs which can be applied in dynamic digital applications, such as virtual simulations, virtual labs, live presenters, Augmented Reality (AR) Virtual Reality (VR) and interactive animation. In the application of digital technology-assisted learning, a learning model that is also integrated with technology such as Practice-Based Education (PBE) is needed. Research is recommended in analyzing the use of digital learning media, especially AI and virtual applications that support PBE. This research supports innovative learning planning research, especially in the topic of digital technology-based learning innovation.

1 Introduction

Global sustainable development targets often referred to as (Sustainable Development Goals) SDGs are a form of program that has been agreed upon by all countries as a form of commitment to build a more decent life. There are 17 main goals in the SDGs with a description of each target specifically [1,2]. Of course, this goal is relevant to the development of the era of technology adoption in the 21st century. One of the targets of the SDGs is to create quality education [3]. In point 4 of the SDG, quality education, especially creating education that maximizes the use of 21st century technology. 21st century technology has very distinctive and different characteristics compared to previous eras. Especially in terms of digitalization, unlimited connections and accessibility [1]. This is a hope in creating quality education in a modern way and being able to adapt to current technological developments.

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The current reality is that the use of technology in education is still relatively low [4,5]. International research has still found minimal development in students' abilities in using modern technology in educational units. Limited infrastructure and teacher competence are obstacles in improving students' abilities. In 2024 World Digital Competitiveness Ranking (WDCR) report by the International Institute for Management Development (IMD), the average global digitalization skills are at an intermediate level and are not evenly distributed across countries [6,7]. The ability of the younger generation to adapt the technology is still low, even though in future global competition it will not be separated from the use of digital technology.

The main problem identified is the lack of knowledge and application of digital technology in schools [8]. In fact, learning habits in schools affect a person's quality in implementing them in community activities. The implementation of digital learning has not been optimally applied in educational institutions today [9]. There are not many digital technologies that are capable and suitable to be applied in learning models. Especially in social science learning, which emphasizes exploration activities, theories and mathematical studies [10]. Based on all of that, the purpose of this study is to analyze the potential for technology integration in education in internationally indexed scientific journals (Scopus). As well as, analyzing recommendations for learning models and media that support the implementation of technology-integrated education activities. These results are aligned in the application of technology in accordance with quality education standards in the scope of social science. Thus, this study is expected to provide a comprehensive knowledge mapping as a basis for developing innovative and sustainable education policies and learning practices.

2 Methods

2.1 Types of research

The research was carried out with a literature review study through bibliometric analysis. Bibliometric analysis aims to measure and understand the development of issues, knowledge and problems based on publication findings [11]. By systematically analyzing the literature through bibliometric analysis, it can be the basis for decision making or further research findings [12,13].

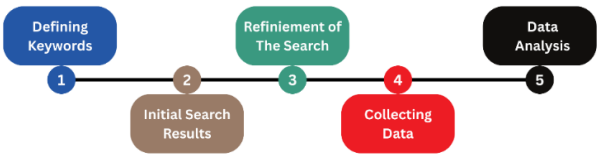


Fig. 1. Research Design

2.2 Instruments and data processing

The SLR (Systematic Literature Review) instrument is used in bibliometric data processing in measuring, observing distribution maps, visualization, and relationships between words assisted by VOSViewer [14]. With the PRISMA chart design, SLR is carried out according to the selected topic.

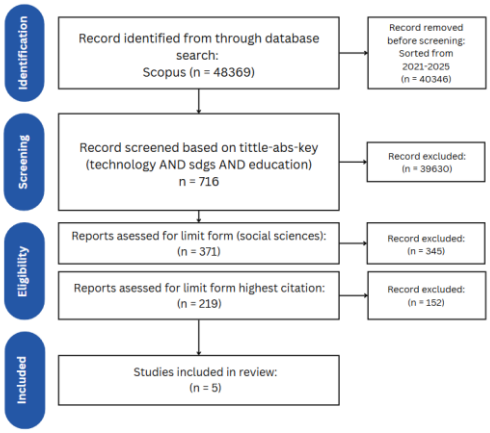


Fig. 2. PRISMA Chart

From the data, document sources, most affiliations, research citations, countries, fields of study, best title sources, countries, authorship, and keywords will be searched. The results of the bibliometric analysis are generalized in obtaining findings on integrated learning development in digital technology in the last 5 years.

3 Result and discussion

3.1 Result

The trend of document publication from 2021-2025 obtained 716 documents referring to the keywords "technology AND sdgs AND education". The filter results from the topics studied were only limited to the material "social science" obtained data of 371 documents but only 219 documents were cited as shown in Figure 3. Based on Figure 3, there is a trend of increasing number of documents published in in-depth learning of physics to improve problem-solving skills. Every year, the number of documents continues to increase. From 2021-2024 is the year with the most significant increase in documents with the most documents of 144 documents in 2024. Meanwhile, in 2025 there were 63 documents because the research was still conducted in May 2025. The publication trend shows an interest in learning by integrating technology as a supporter in the learning model and educational media, integrating technology in social science learning with various fields including in-depth learning achievements towards point 4 of the SDGs [15,16].

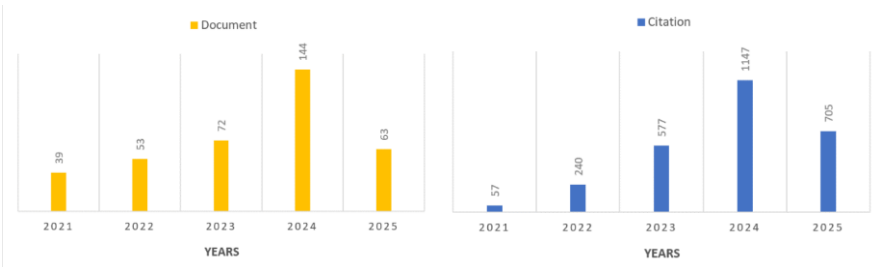


Fig. 3. Document and Citation per Year

Next, there are types of sources depicted in Figure 4. The most widely used types of sources are journals with 218 article publications and books with 71 documents. These results

indicate that researchers tend to have journals as place to publish research related to deep learning physics to improve problem-solving skills. In addition, Figure 5 also found documents with different subject areas with the highest level of social science coverage of 371 and computer science 136 documents.

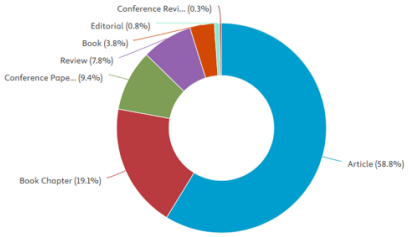


Fig. 4. Document Types

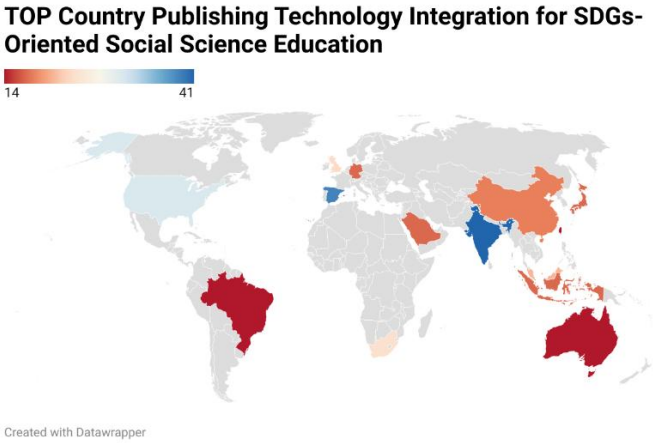


Fig. 5. Top 10 Countries contributed to technology integration for SDGs publication

In the last five years, the top 10 countries contributing to technology integration research for SDGs social science education were India, Spain, United States, South Africa, United Kingdom, Malaysia, China, Germany, Indonesia and Japan. The data obtained are visualized in Figure 5. From the data obtained, in first place is India with 41 documents and Spain with 39 documents. From these data, it is known that researchers in India and Spain are very interested in technology integration research for SDGs-oriented social science education. Based on the number of publications made, it can be seen that almost the entire world population is aware of the importance of technology integration in education today. The following is a mapping of countries that can increase their contribution to the deep learning approach to improve problem solving with machine learning innovation.

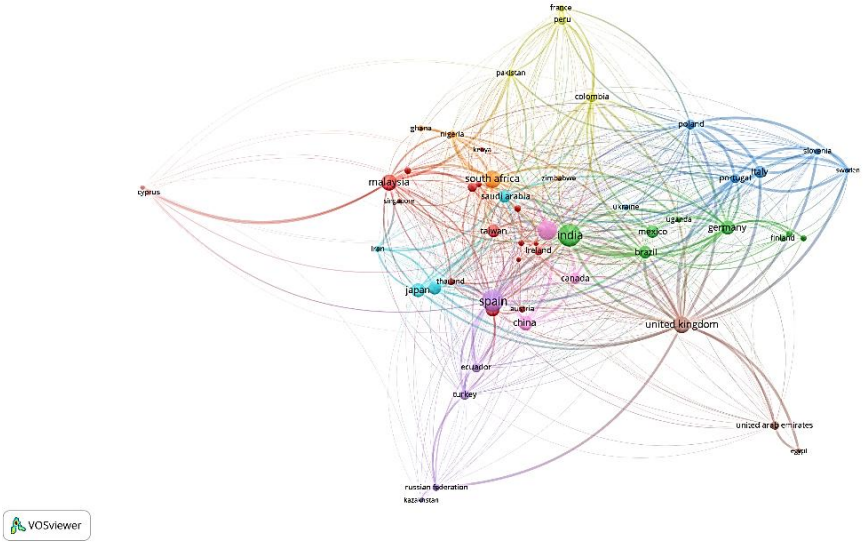


Fig. 6. The relation of countries contributing to technology integration for SDGs publication

Based on the distribution of each country, 10 top sources of documents/journals were also found that support technology integration for SDGs-oriented social science education publications. Details of the distribution of the top 10 sources supporting this research are as follows,

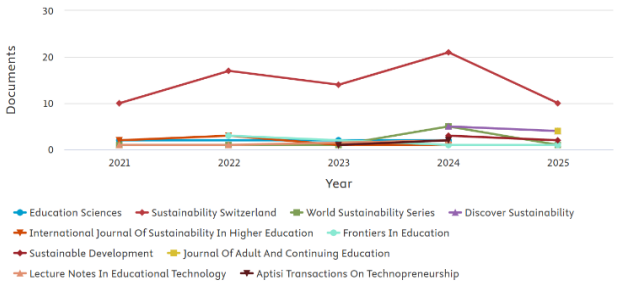


Fig. 7. Number of article by sources (Top 10 sources)

The data obtained will be visualized in Figure 8, the results of the keyword mapping "technology integration for SDGs-oriented social science education". In this study, there are many different clusters with the 5 highest clusters.

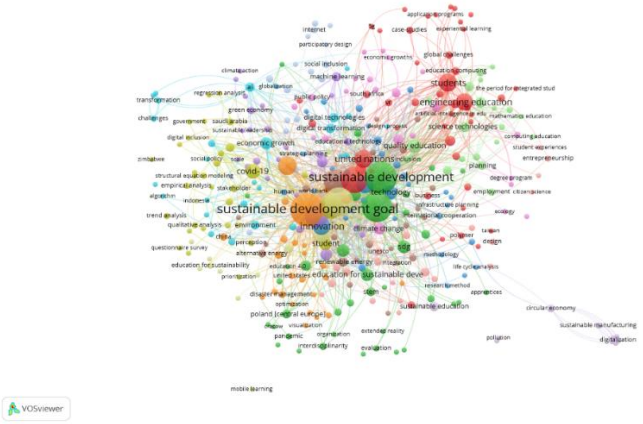


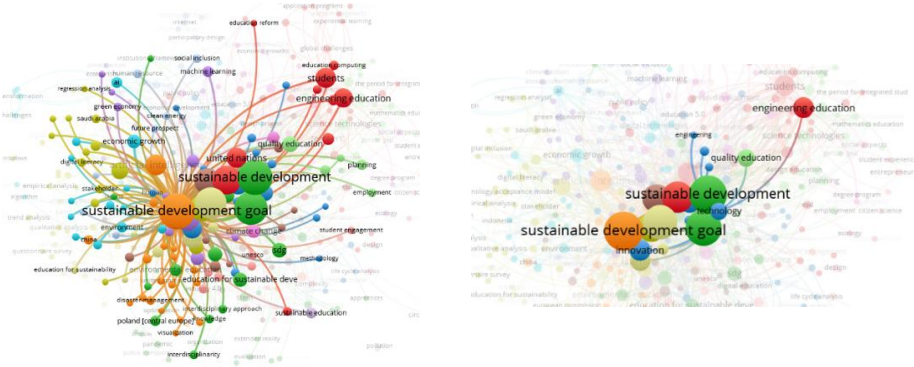
Fig. 8. Network visualization

In cluster 1 there are 240 items with the most significant emergence, namely sustainable development goals. Furthermore, in cluster 2 there are 239 items with the most significant emergence including sustainable development. Then in cluster 3 consisting of 199 items, the keyword with the most emergence is education. In cluster 4 there are 90 items with the largest emergence of engineering education and students. Then, in cluster 5 there are 63 items with the most significant keyword technology. Next, the results of the mapping of keywords that support technology integration for SDGs-oriented social science education publications found the highest occurrence value of 82 for the words "Sustainable Development Goal" and the top 10 keywords based on distribution were found as follows,

Table 1. Top 10 keywords by author

Rank	Keywords	Total Link Strength	Rank	Keywords	Total Link Strength
1	Sustainable Development Goal	656	6	Education	269
2	Sustainable Development	534	7	Higher Education	259
3	Sustainability	410	8	Teaching	213
4	Sustainable Development Goals	336	9	Sustainable Development Goals (Sdgs)	210
5	Sdgs	280	10	United Nations	196

Top 10 Keywords By AuthorsThe most significant keywords determine the occurrences that are the main topics that attract researchers' attention related to the research. Meanwhile, keywords that have fewer occurrences indicate that some studies focus on the subtopic “Technology Integration for SDGs-Oriented Social Science Education” Therefore, to find the novelty of research with technology integration that focuses on education, the investigation will be conducted using the occurrence visualization in Figure 9.



(a) (b)

Fig. 9. Correlation of sustainable development goals, education and technology

Figure 9 shows a more specific keyword mapping of the Correlation of sustainable development goals in publications. The main trends discussed in this study are shown in Figures 9 (a) and 9 (b) which are related to potential future research. In Figure 9 (a), the main keyword, SDGs (Sustainable Development Goals), is related to various keywords such as sustainable development, quality education, environment, climate change, united nations, students, sdg, sustainable education, machine learning and others. Furthermore, to link technology integration, it can be seen in Figure 11, where technology can be related to several keywords that show the relationship in supporting SDGs-oriented social science education. In the application of the study, the largest subject keyword was found to be students, as shown in the figure below.

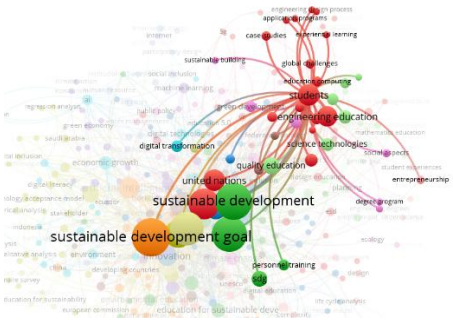


Fig. 10. Student involvement in research

Figure 10 shows that research development is very likely to be aimed at student samples or populations. This is related to other keywords, especially sustainable development, sustainable development goals, education, engineering education, quality education and others. Thus, the application of education with technology integration can create one of the pillars towards the SDGs, in other words, technology integration can support social science learning activities that can realize SDG 4 quality education. In sharpening findings and recommendations, an overview of the paper with the largest number of citations is needed. Like a literature review in knowing the advantages and disadvantages to create research potential in the future [17,18].

Table 2. Overview of most cited papers in technology integration for SDGs-Oriented social science education

Author(s)	Citation; SJR	Research Findings and Recommendations
David Mhlanga (2021)	215; 12.16 (Q1)	Overview of most cited papers in technology AI has a strong influence on achieving the SDGs, especially in poverty reduction and infrastructure development in developing countries. Governments in developing countries are advised to increase investment and research in the field of artificial intelligence to accelerate the achievement of SDGs related to innovation, infrastructure, and poverty alleviation.gy integration for SDGs-oriented social science education
Tapalova Olga, Zhiyenbayeva Nadezhda (2022)	202; 22.4 (Q2)	The application of artificial intelligence in education can create personalized learning paths, increase learning effectiveness through material adaptation, real-time feedback, and flexible contextual learning.
Llewellyn et al. (2021)	111; 9.43 (Q1)	Practice-Based Education (PBE) offers a holistic approach to engineering education that is more effective in addressing the complexity of global problems than the traditional PBL structure.
Khaled et al. (2021)	109; 5.77 (Q1)	The majority of research on solar PV technology focuses on SDG 7 (Affordable and Clean Energy), while there is still little attention to its contribution to other SDGs such as poverty alleviation, education, and equality. Researchers and policymakers are advised to expand the scope of solar PV research to include its contribution to other SDGs, in order to maximize the role of solar energy in sustainable development holistically.
Mabkhot et al. (2021)	90; 5.76 (Q1)	Industry 4.0 technologies generally make a positive contribution to the achievement of the SDGs, although their impact on each goal varies from strong and direct to weak and indirect. Policymakers are advised to strategically integrate I4.0 technologies into cross-sectoral policies to maximize their contribution to all SDGs.

Overall, Industry 4.0 technology generally makes a positive contribution to achieve the SDGs [19]. A holistic approach to education is a more effective technique in dealing with the complexity of global problems.

3.2 Discussion

Based on the 2021-2025 document trend data related to the potential for technology integration for SDGs-oriented social science education, it was obtained quite stable. There has been an increase in global research from the last 5 years which can be a strengthening in implementing the use of technology in education to achieve point 4 of the SDG of quality education. Based on a bibliometric analysis of the 371 documents obtained, a correlation was found between the use of technology that supports sustainable development. Technology integration is not only found in the implementation of education, but in implementing 21st century education, maximum technology adaptation is needed [20,21]. Especially in social science education, where social science education requires technology integration for several important reasons related to the relevance, effectiveness, and quality of learning. Social science education not only teaches content, but also critical thinking skills, communication, collaboration, and digital literacy [3,22,23].

In the findings of several relevant studies reviewed based on the number of top citations with high similarity where technology integration can be realized in various approaches.

Technology can be used as a support for the use of systems or the system itself [24]. One of the most phenomenal is the use of AI. The application of artificial intelligence in education is able to create personalized learning paths, increase learning effectiveness through material adaptation, real-time feedback, and flexible contextual learning [25,26]. The application of technology implemented in dynamic media can help teachers improve students' abilities [27].

In the implementation of digital technology-assisted learning, a learning model that is also integrated with technology is needed. Based on Table 2, in addition to the findings of the use of AI in the learning process, an effective learning model was also found to be used by integrating technology. One of them is Practice-Based Education (PBE) which offers a comprehensive approach to more effective engineering education [28]. This is almost similar to other meaningful learning such as PBL, PjBL and Inquiry. As in social science, there are materials on SDG 7 (clean and affordable energy), SDG 11 (sustainable cities and settlements), and SDG 13 (climate change) [29]. Awareness of the SDGs can be provided through the materials taught in schools.

Implementing learning with technology integration through the use of appropriate media and learning models can improve the quality of education. This is because one aspect of point 4 of the SDGs is the implementation of digital technology to improve the skills and competencies of the younger generation [15]. Therefore, in-depth research into the use of digital learning media, especially AI and virtual applications that support PBE, has great potential to be developed. At the same time, as an innovation in further research, an in-depth analysis of the characteristics of the media needed as a form of using 21st century technology to improve skills in social science learning can also be carried out. The advantage of the bibliometric analysis in this study is that it is known the trend and correlation of the topic of technology integration in social science education that is oriented towards SDGs globally. The disadvantage of this study is the limitation in sampling "key words" in the bibliometric analysis.

4 Conclusion

Based on the research that has been conducted, it is known that the research trend of technology integration for SDGs-oriented social science education over the past 5 years has continued to increase every year. The discovery of AI has a strong influence on achieving the SDGs which can be applied in dynamic digital applications, such as virtual simulations, virtual labs, live presenters, Augmented Reality (AR) Virtual Reality (VR) and interactive animation. In the application of digital technology-assisted learning, a learning model that is also integrated with technology is needed, such as PBE which offers a comprehensive approach to more effective engineering education. Future research is recommended in analyzing the use of digital learning media, especially AI and virtual applications that support PBE. This study can be supporting data to strengthen future research, especially in the topic of digital technology-based learning innovation.

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