



Artificial Intelligence Research During COVID-19 Pandemic: Contributed to Future Education

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Besides being able to cause death, it turns out that the COVID-19 pandemic has caused problems in various sectors, including education, health, and Social Life. In addition, the COVID-19 pandemic also has an impact on the field of research, including the field of Artificial Intelligence (AI) which has become an interesting issue in the era of the Industrial Revolution 4.0. Based on Scopus data (search by article title, abstract, and keywords), it shows that there are 381,691 documents. Results of Bibliometric through VOSViewer found some parameters or interrelationships among variables to capture the trend and novelty of researching on AI During COVID-19 Pandemic, such as researching on AI During COVID-19 Pandemic and technology, detection, patient, diagnosis, performance, radiologist, feature, education, and image. Implication research in general evidence, (1) AI researchers have bright career opportunities in the present and the future. This is evident from the condition of the central role of AI in all lines of human life, (2) The trend of AI research is also classified as having a very large contribution to have entered various fields during the COVID-19 pandemic. (3) Including the prevention of COVID-19 transmission with AI, various tools and media have emerged in the medical world that provides many benefits. (4) AI needs more exploration in education field research. In the last five years, AI has made a major contribution advancing the field of education.

Keywords: artificial intelligence, bibliometric, coronavirus, covid-19, education, VOSViewer

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INTRODUCTION

Besides being able to cause death, it turns out that the COVID-19 pandemic has caused problems in various sectors, including education (Al-Ghanimi & Al-Ghanimi, 2021; Boonroungrut et al. 2022; Brown, 2021; Busaad & Alnaim, 2021; Choon et al., 2021; Herzallah & Stavisky, 2021; Rofiah et al., 2022; Shen et al., 2021; Yu, 2021), health (Ahmed et al., 2021; Ferron et al., 2021; Rabiei, 2021; Simon & Regan, 2021; Woolcott & Castilla-Bancayán, 2021), and Social Life (Alfawaz et al., 2021; Gozzi et al., 2021; Hallman et al., 2021; Khataee, 2021; Ruiz-Medina et al. al., 2021). In addition, the COVID-19 pandemic also has an impact on the field of research, including the field of Artificial Intelligence which has become an interesting issue in the era of the Industrial Revolution 4.0. Based on Scopus data (search by article title, abstract, and keywords) as, it shows that there are 381,691 documents.

Artificial intelligence (AI) is intelligence that is represented by a machine to show the behaviour of the object you want to imitate and all of this is used to facilitate human work in various fields (Aphinives & Aphinives, 2021; Cox, 2021; Crea, 2021; Goh et al., 2021; Karaca et al., 2021; Pepic et al., 2021; Rahimunnisa et al., 2021 Scheetz et al., 2021; Secinaro et al., 2021; Tamilselvi et al., 2021). Based on the need and importance of the role of AI, there is an urgency to carry out holistic research based on Bibliometric analysis related to the research trend of AI during Covif-19 pandemic. This research will serve as empirical evidence and obtain profile research for other researchers who are interested in and focus on the field of Artificial Intelligence today and in the future.

In the last five years (2017-2021) there have been many recent studies that prove the effectiveness of VOSViewer in research indexed by Scopus, including: Putri et al. (2021), Han & Gong (2021), Xin et al. (2020), Wenxuanzi & Li (2020), Yu & Lin (2020), Yu (2020), Hu et al. (2019), Shah et al. (2019), Haijiao et al. (2019), Gao et al. (2018), Ye (2018), Wong (2018), and van Eck & Waltman (2017). Therefore, the research will focus on obtaining research trends profiles of AI During the COVID-19 Pandemic which are analysed using Bibliometric assisted by VOSViewer. The specific objectives of the research are as below:

1. To know the top document type, document source, language sources, and country of research trend AI during COVID-19 pandemic.
2. To know the top affiliation and funding sponsor of research trend AI during COVID-19 pandemic.
3. To know the top source title, subject area, and citation of research trend AI during COVID-19 pandemic
4. To identify the visualization research trend of AI during COVID-19 pandemic.
5. To study the contributed AI in education.

METHOD

The research using bibliometric analysis which is proven to have been able to find novelties and research trends (Agbo et al., 2021; Adegioriola et al., 2021; Du et al., 2021; Kulakli & Osmanaj, 2020; Lu et al., 2021; Niu et al., 2021; Xia et al., 2021; Zyoud, 2021). The article document used comes from Scopus datadase. This is based on

the consideration of Scopus' credibility as a publication media for researchers in the world. The term "Artificial Intelligence During COVID-19 Pandemic" were used as the filter to search titles, abstracts, and keywords from all years. The general research procedure are:

- ❖ determine topic "Artificial Intelligence During COVID-19";
- ❖ optimized Elsevier's Scopus database;
- ❖ download RIS and CSV;
- ❖ analyze data RIS using VOSViewer software (Eck & Waltman, 2018; Adegioriola et al., 2021; Wang et al., 2021; Yang et al., 2017);
- ❖ analyse data CSV using Microsoft Excel;
- ❖ interpretation;
- ❖ get profile the Research Trend of Artificial Intelligence During COVID-19 Pandemic.

It was 1,568 documents of whole years (As May 8, 2021). In this research, VOSViewer software was used to figure out bibliometric analyse (Hamidah et al., 2020; Al-Ashmori et al., 2020; Huang et al., 2020; Xie et al., 2020; Huang et al., 2020) on the research trend AI During COVID-19 Pandemic.

FINDINGS

Top Document Type, Document Source, Language Sources, and Country of Research Trend AI during COVID-19 pandemic

There were 1,568 papers associated with AI During COVID-19 Pandemic research in the Scopus database. 1,568 papers have been distributed in two years, especially in 2021 (639) and 2020 (929). Document sources of AI during COVID-19 pandemic research including 5 document type from Article (789), Conference Paper (310), Review (210), Editorial (6) and Book Chapter (57) see in Table 1. Based on document source from Journal (1,159), Conference Proceeding (261), Book Series (141), Trade Journal (6), and Book (1). Furthermore, out of a total of 1,568 documents, most documents used English as the language of articles (1,519), Chinese (21), Spanish (16), French (6), and German (5). The Scopus documents from Country/Territory are United State (380) in top, India (254), China (231), United Kingdom (164) and Italy (117) see detail Table 1.

Table 1

Top document type, document source, language sources, and country/territory of AI during COVID-19 pandemic

Document Type	Total	Document Source	Total	Language Source	Total	Country/Territory	Total
Article	789 (50.3%)	Journal	1,159 (73.9%)	English	1,519 (96.9%)	United State	380 (24.2%)
Conference Paper	310 (19.8%)	Conference Proceeding	261 (16.6%)	Chinese	21 (1.3%)	India	254 (16.2%)
Review	210 (13.4%)	Book Series	141 (9.0%)	Spanish	16 (1.0%)	China	231 (14.7%)
Editorial	60 (3.8%)	Trade Journal	6 (0.4%)	French	6 (0.4%)	United Kingdom	164 (10.5%)
Book Chapter	57 (3.6%)	Book	1 (0.1%)	German	5 (0.3%)	Italy	117 (7.5%)

Top Affiliation and Funding Sponsor of Research Trend AI during COVID-19 Pandemic

Top five affiliation of AI during COVID-19 pandemic are Harvard Medical School (24), Huazhong University of Science and Technology (22), Imperial College London (20), Tongji Medical College (20), and Massachusetts General Hospital (18). For top five Funding Sponsor affiliation of AI during the COVID-19 pandemic are the National Natural Science Foundation of China (52), European Commission (40), National Institutes of Health (35), U.S. Department of Health and Human Services (34), Ministry of Science and Technology of the People's Republic of China (21) see detail in Table 2.

Table 2

Top affiliation and funding sponsor of AI during COVID-19 pandemic

Affiliation	Total	Funding Sponsor	Total
Harvard Medical School	24 (1.5%)	National Natural Science Foundation of China	53 (3.4%)
Huazhong University of Science and Technology	22 (1.4%)	European Commission	40 (2.6%)
Imperial College London	20 (1.3%)	National Institutes of Health	35 (2.2%)
Tongji Medical College	19 (1.2%)	U.S. Department of Health and Human Services	34 (2.2%)
Massachusetts General Hospital	18 (1.1%)	Ministry of Science and Technology of the People's Republic of China	21 (1.3%)

Top Source Title, Subject Area, And Citation of Research Trend AI during COVID-19 Pandemic

Top five documents of Research Trend AI during COVID-19 Pandemic from Journal indexed by Scopus are Lecture Notes in Computer Science (38), Journal of Medical Internet Research (29), International Journal of Environmental Research and Public Health (22), Studies in Systems Decision and Control (21), and Studies in Computational Intelligence (19). Top five document of Research Trend AI during COVID-19 Pandemic from Conference Proceeding indexed by Scopus ACM International Conference Proceeding Series (22), Ceur Workshop Proceedings (16), and Journal of Physics Conference Series (13), detail in top ten see Table 3.

Table 3
Top source title, subject area, and citation of AI during COVID-19 pandemic

Source Title	Total	Subject Area	Total	Citation	Total
Lecture Notes In Computer Science	38	Medicine	650	Liu, S. et al. (2020) The Lancet Psychiatry	496
Journal Of Medical Internet Research	29	Computer Science	621	Stebbing, J. et al. (2020) The Lancet Infectious Diseases	424
ACM International Conference Proceeding Series; International Journal Of Environmental Research And Public Health	22	Engineering	366	Yang, Z. et al. (2020) Journal of Thoracic Disease	343
Studies In Systems Decision And Control	21	Mathematics	199	Ozturk, T. et al. (2020) Computers in Biology and Medicine	281
IEEE Access; Studies In Computational Intelligence	19	Biochemistry, Genetics and Molecular Biology	171	Ting, D.S.W. et al. (2020) Nature Medicine	253
Advances in Intelligent Systems and Computing; Ceur Workshop Proceedings	16	Social Sciences	138	Li, L. et al. (2020) Radiology	243
Communications in Computer and Information Science; Journal Of Physics Conference Series	13	Decision Sciences	134	Soldati, G. et al. (2020) Journal of Ultrasound in Medicine	165
Computers Materials and Continua; IEEE Journal of Biomedical And Health Informatics	12	Physics and Astronomy	95	Vaishya, R. et al. (2020)	150
Computers in Biology and Medicine; European Radiology; Lancet Digital Health	11	Materials Science	79	Mei, X. et al. (2020) Nature Medicine; Torous, J. et al. (2020) JMIR Mental Health	133
Chaos Solitons and Fractals; Radiology; Springer briefs In Applied Sciences And Technology	10	Health Professions	75	Chamola, V. et al. (2020) IEEE Access	117

For update information to researcher especially in Subject Area: Medicine (650) and Computer Science (621) be top leader, Engineering (366), Mathematics (199), Biochemistry, Genetics and Molecular Biology (171), Social Sciences (138), Decision Sciences (134), Physics and Astronomy (95), Materials Science (79), and Health Professions (75). Document of Research Trend AI during COVID-19 Pandemic based on Citation from Journal indexed by Scopus detail in **Table 3**. In the top rank of citation are Liu, S. et al. (2020) get 496 citations; 424 citations of Stebbing, J. et al. (2020); 343 citations of Yang, Z. et al. (2020); 281 citations of Ozturk, T. et al. (2020); 253 citations of Ting, D.S.W. et al. (2020).

Based on Table 3, we can take a research trend in which AI can cover all scientific fields in the world. These results also show how important AI is in human life. AI researchers have a great chance of success today and in the future. The Industrial Revolution 4.0 and the COVID-19 pandemic will be a catalyst and accelerate our readiness in the era of Society 5.0, in which AI will play a central role.

Visualization Research Trend of AI during COVID-19 Pandemic

Among those 1,568 papers related AI during COVID-19 pandemic research in the Scopus database, then the researchers visualised the research trends on this topic assisted with VOSViewer software (see Figure 1a, 1b, and 1c). This effort is useful for finding the novelty of the research in this domain.

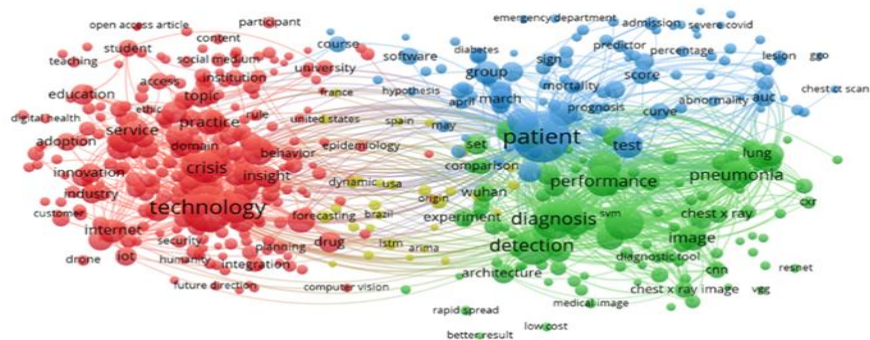


Figure 1a

The network visual of research on AI during COVID-19 pandemic

Figure 1a indicates the whole picture research on AI during COVID-19 pandemic. Researchers on the world produced four clusters (indicated with red, blue, green, and yellow). The first cluster (red colour) was AI during COVID-19 pandemic as technology related to innovation, student, service, internet, education, industry, security, crisis, and future direction. The second cluster (blue) was AI during COVID-19 pandemic focus on patient in relating to test, abnormality, prognosis, score, predictor, group, mortality, scan, sign, and emergency department. The third cluster (green) was AI during COVID-19 pandemic in connecting with performance, pneumonia, diagnosis, detection, chest x ray, medical image, diagnostic tool, and lung. The fourth cluster (yellow) as lowest indicated AI during COVID-19 pandemic in relating to United States, Spain, USA, BRAZIL, origin and dynamic.

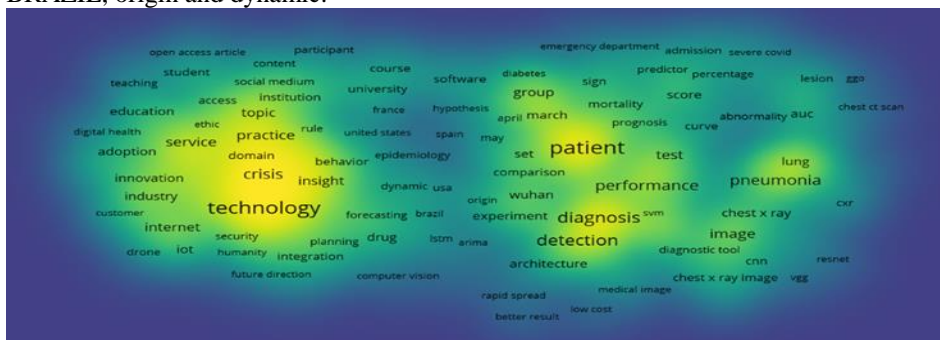


Figure 1b

The density visual of research on AI during COVID-19 pandemic

Figure 1b shows the depth of research on AI during COVID-19 pandemic are technology, insight, crisis, practice, service, patient, diagnosis, detection, performance, and pneumonia. Another finding is that the fading colours indicate an increasing trend in related research (see keywords and title). The result is only two years, namely 2020 and 2021 with an increasing trend. Figures 1a-1b indicate the keywords that most often appear on AI during the COVID-19 pandemic are technology, patient, diagnosis, detection, performance, and pneumonia. From these data we can find novelty from AI research during the COVID-19 pandemic. For example, we can take the field of education. Not many AI during COVID-19 pandemic have taken up the topic of practicing higher order thinking skills (HOTs). AI during COVID-19 pandemic is the most dominant use of technology in the health sector. This could still be an opportunity for present and future AI research, especially the implementation of AI in the health sector with the keywords patient, diagnosis, detection, and pneumonia.

For subjects that have become the top ten can be seen in Table 3. Furthermore, researchers don't need to start from zero to determine research topics related to AI implementation. Figure 2 shows the findings indicated some parameters or interrelationships among variables to capture the trend and novelty of researching on AI During COVID-19 Pandemic, such as researching on AI During COVID-19 Pandemic and technology, patient, diagnosis, performance, radiologist, feature, education, and image.

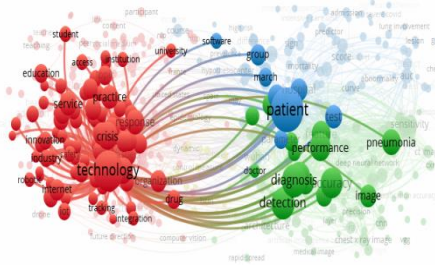


Figure 2a. Technology

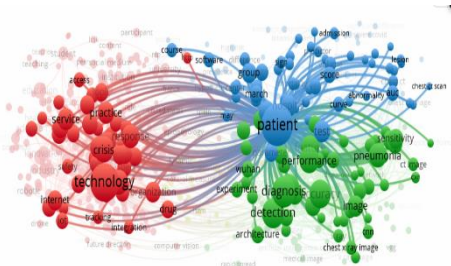


Figure 2b. Patient

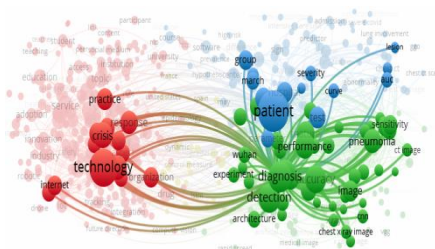


Figure 2c. Diagnosis

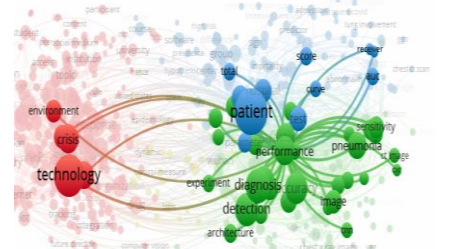


Figure 2d. Performance



Figure 2e. Radiologist

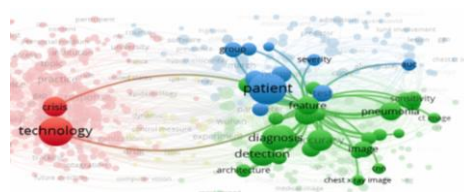


Figure 2f. Feature

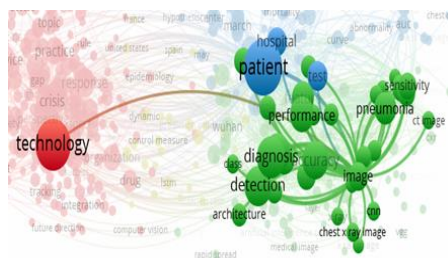


Figure 2g. Image

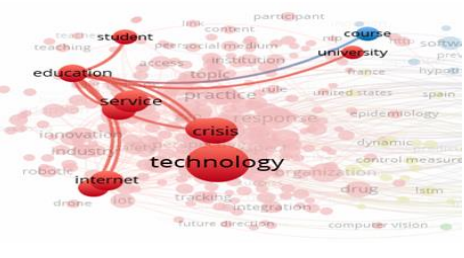


Figure 2h. Education

Figure 2

Trend and novelty on AI during COVID-19 pandemic recent and future research

Figures 2a-2d are the results of the top trends in AI research during the COVID-19 Pandemic 2020-2021. For other research that wants to explore the field of AI, they still have a great chance of success. This is illustrated by the bibliometric results which found that AI can reach all aspects of human life. AI can be in the fields and studies of technology, patient, diagnosis, and performance. Researchers can carry out development research related to AI. Figures 2e-2h can be used as research alternatives, especially for researchers who want to focus on integrated AI in education and health aspects. For example, a researcher wants to take AI in the radiologist field (see Figure 2e), it can focus on aspects of diagnosis, performance, detection, patient, and image. If the researcher wants to do something that is still rarely researched, then the researcher can choose to focus on integrated AI in CT images and CXR. Figures 2f-2g provide evidence on the AI field that still has high opportunities related to research on AI features and images that are associated with patient diagnosis, detection, architecture, technology, severity, pneumonia, sensitivity, image, chest x ray image, ct image. Researchers interested in developing AI in education are shown in Figure 2h. AI researchers have a broad scope in the field of education, including AI that is relevant to students, service, internet, crisis, technology, courses and universities.

Contributed Artificial Intelligence in Education

Table 4
The Top Article “Artificial Intelligence in Education” for all year

Document title	Authors	Source	Cited by
Exploring the impact of artificial intelligence on teaching and learning in higher education	Popenici & Kerr (2017)	Research and Practice in Technology Enhanced Learning 12(1),22	127
Robot-proof: Higher education in the age of artificial intelligence (Book)	Aoun (2017)	Robot-Proof: Higher Education in the Age of Artificial Intelligence pp. 1-187	116
Systematic review of research on artificial intelligence applications in higher education – where are the educators?	Zawacki-Richter, et al. (2019)	International Journal of Educational Technology in Higher Education 16(1),39	96
Artificial Intelligence trends in education: A narrative overview	Chassignol et al. (2018)	Procedia Computer Science 136, pp. 16-24	93
Artificial Intelligence in Medical Education: Best Practices Using Machine Learning to Assess Surgical Expertise in Virtual Reality Simulation	Winkler-Schwartz et al. (2019)	Journal of Surgical Education 76(6), pp. 1681-1690	67
Artificial Intelligence trends in education: A narrative overview	Chassignol et al. (2018)	Procedia Computer Science 136, pp. 16-24	53
Web Intelligence and Artificial Intelligence in Education	Devedžić, V. (2004)	Educational Technology and Society 7(4), pp. 29-39	41
Artificial Intelligence in Medical Education: Best Practices Using Machine Learning to Assess Surgical Expertise in Virtual Reality Simulation	Winkler-Schwartz, A., (2019)	Journal of Surgical Education 76(6), pp. 1681-1690	40
Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature	Hinojo-Lucena et al. (2019)	Education Sciences 9(1),51	35
Toward Augmented Radiologists: Changes in Radiology Education in the Era of Machine Learning and Artificial Intelligence	Tajmir, S.H., Alkasab, T.K.	Academic Radiology 25(6), pp. 747-750	31

Table 4
The top article “artificial intelligence in education” for all year

Document title	Authors	Finding	Recommendations
Exploring the impact of artificial intelligence on teaching and learning in higher education	Popenici & Kerr (2017)	Recent technological advancements and the increasing speed of adopting new technologies in higher education are explored in order to predict the future nature of higher education in a world where artificial intelligence is part of the fabric of our universities. Researchers pinpoint some challenges for institutions of higher education and student learning in the adoption of these technologies for teaching, learning, student support, and administration and explore further directions for research.	Focus further research on the new roles of teachers on new learning pathways for higher degree students, with a new set of graduate attributes, with a focus on imagination, creativity, and innovation; the set of abilities and skills that can hardly be ever replicated by machines.
Systematic review of research on artificial intelligence applications in higher education – where are the educators?	Zawacki-Richter, et al. (2019)	Most of the disciplines involved in Artificial Intelligence in Education (AIED) papers come from Computer Science and STEM, and that quantitative methods were the most frequently used in empirical studies. The synthesis of results presents four areas of AIED applications in academic support services, and institutional and administrative services: 1. profiling and prediction, 2. assessment and evaluation, 3. adaptive systems and personalisation, and 4. intelligent tutoring systems. The conclusions reflect on the almost lack of critical reflection of challenges and risks of AIED, the weak connection to theoretical pedagogical perspectives, and the need for further exploration of ethical and educational approaches in the application of AIED in higher education.	There is very little evidence for the advancement of pedagogical and psychological learning theories related to AI driven educational technology. It is an important implication of this systematic review, that researchers are encouraged to be explicit about the theories that underpin empirical studies about the development and implementation of AIED projects, in order to expand research to a broader level, helping us to understand the reasons and mechanisms behind this dynamic development that will have an enormous impact on higher education institutions in the various areas we have covered in this review.
Artificial Intelligence trends in education: A narrative overview	Chassignol et al. (2018)	From the overview it is clear that AI tools are already implemented in many parts of educational process including content development, teaching methods, student assessment, and communication between teacher and students.	This work contributes to existing knowledge on this domain and will be interesting to professionals in the field of technology enhanced learning, lecturers, students and people who cares about state of the art of our education.
Artificial Intelligence in Medical Education: Best Practices Using Machine Learning to Assess Surgical Expertise in Virtual Reality Simulation	Winkler-Schwartz et al. (2019)	Important differences in reporting were found between medical and computer science journals. The medical journals proved stronger in discussion quality and weaker in areas related to study design. The opposite trends were observed in computer science journals. This checklist will aid in narrowing the knowledge divide between computer science, medicine, and education: helping facilitate the burgeoning field of machine learning assisted surgical education.	Artificial intelligence systems may be developed to not only classify participants according to surgical expertise but to coach trainees to a defined surgical standard. These systems will allow for the conduct of studies to further elaborate the proper approach in using this technology in the teaching of psychomotor skills. Regardless of what the future holds, a clear understanding of surgery, artificial intelligence methodologies, and educational best practices will be crucial to the ultimate success of these systems.

Document title	Authors	Finding	Recommendations
Web Intelligence and Artificial Intelligence in Education	Devedžić, V. (2004)	The key advantages of applying WI techniques to AIED are enhanced additivity and enhanced learner comfort. WI enables course sequencing and material presentation not only according to the learner model, but also according to the most up-to-date relevant content from the Web. Automatic discovery, invocation, and composition of educational Web services can free the learner from many time-consuming activities that often disrupt the learning process itself. Finally, ontology-supported learning process greatly increase automation of a number of learners', teachers', and authors' activities related to Web-based learning environments.	True, a number of issues covered in the paper look as a wish list at the moment. For example, pedagogical agents are still not a common facility, neither are educational ontologies and services, hence educational servers are at best an experiment. Fortunately, this is highly likely to change in the foreseeable future. The reason is the fact that the enabling Web technologies are evolving rapidly. Moreover, it took just a couple of years to get from XML and XML Schema to much more abstract representational languages like OWL.
Artificial intelligence in higher education: A bibliometric study on its impact in the scientific literature	Hinojosa-Lucena et al. (2019)	the most cited article on artificial intelligence in higher education in both databases refers to the implementation of virtual tutoring as one of the main systems to the improvement of learning. The second and third articles that appear in WOS and Scopus focus on intelligent systems to predict a student's mood ("Prediction of student's mood during an online test using formula-based and neural network-based methods") and to detect learning styles ("An enhanced Bayesian model to detect students' learning styles in Web-based courses"), in line with the considerations on the applications of artificial intelligence in higher education. Although artificial intelligence is a reality, the scientific production about its application in higher education has not been consolidated.	As a future research line, it would be interesting to continue improving the bibliometric analysis of the scientific production on artificial intelligence in higher education, pointing out the trends in the themes of publications about this topic for each year. Artificial intelligence applied to education must remain a focus of interest and attract more research, producing journal articles that will advance our knowledge of this topic and promote its real widespread application.
Toward Augmented Radiologists: Changes in Radiology Education in the Era of Machine Learning and Artificial Intelligence	Tajmir, S.H., Alkasab, T.K.	Radiology practice will be altered by the coming of AI tools, and the process of learning in radiology will be similarly affected. In the short term, radiologists will need to understand the first wave of AI tools and how they can help them improve their practice and be able to effectively supervise their use. Radiology training programs will need to develop curricula to help trainees acquire the knowledge to carry out this new supervisory duty of radiologists.	In the longer term, AI software assistants could have a transformative effect on the training of residents and fellows, and offer new opportunities to bring learning into the ongoing practice of attending radiologists as well.

In the last five years, AI has made a major contribution in advancing the field of education. There is an increase in AI publications in the education sector. This can be seen in Figure 3 which shows that topics in AI have contributed to the development of education, including during the COVID-19 pandemic. AI will be one of the keys to innovating educational developments today and in the future.

CONCLUSIONS

Results of Bibliometric analysis through VOSViewer found some parameters or interrelationships among variables to capture the trend and novelty of researching on AI During COVID-19 Pandemic, such as researching on AI During COVID-19 Pandemic and technology, patient, detection, diagnosis, performance, radiologist, feature, education, and image. Implication research in general evidence, (1) AI researchers have bright career opportunities in the present and the future. This is evident from the condition of the central role of AI in all lines of human life, (2) The trend of AI research is also classified as having a very large contribution to have entered various fields during the COVID-19 pandemic. (3) Including the prevention of COVID-19 transmission with AI, various tools and media have emerged in the medical world that provide many benefits. In future research, (1) For other research that wants to explore the field of AI, they still have a great chance of success. This is illustrated by the bibliometric results which found that AI can reach all aspects of human life, (2) Researchers on AI can be in the fields and studies of technology, patient, diagnosis, and performance, (3) Researchers can carry out development research related to AI on COVID-19 pandemic in such as technology, patient, diagnosis, performance, radiologist, feature, education, and image. In the last five years, AI has made a major contribution in advancing the field of education. AI researchers in the field of education have a bright future to continue making very useful innovations by shifting the educational paradigm in today's world.

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