A Systematic Literature Review with Bibliometric Meta-Analysis of IoT and AI Technology Adoption in Education

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Abstract

Education has endured innumerable developments and variations according to the development of technology and science. Education is one of the main components that uphold the development of a country. Therefore, it is the liability of a country in designing an education system that makes students seek education from every place inhabited at any time. The use of the current technology as Internet of Things (IoT) and Artificial Intelligent (AI) has become an inclination in 21st-century education in providing learning aids that are technological and digital. The purpose of this systematic survey is to identify peer-reviewed literature on the adoption of the Internet of Things and Artificial Intelligent in education. Scopus and Web of Science citation databases are used in the data-gathering phase. Preferred Items for Systematic Reviews and Meta-Analyses (PRISMA) is used as prior approach on this study to review the topic related literatures. Therefore, PRISMA approach and keyword search were extracted and analysed. This bibliographic data of articles published in the journals over the seven years were extracted. VOS viewer was used to analysing the data contained in all journals. The findings show that reviews are showing the utilization and acknowledgment of both technologies in education. Additionally, shows the utilization of both technologies positively affects enhance understanding of the subject among students. However, there is still space to advance its ease of use in education, which is presently in the 4.0 education shift following the improvement of the Industrial Revolution (IR) 4.0. This systematic review found that there is still scope for studies related to IoT and AI. Therefore, researchers in the future need to conduct research related to the integration of these two technologies in education, primarily as student learning materials.

Keywords: Internet of Things; artificial intelligent; meta-analyses; industrial revolution

1. Introduction

The Internet of Things (IoT) and Artificial Intelligent (AI) are newly absorbed technologies in education. The application of the latest technological elements such as this can improve the status of national education and realize the initiative of a government in elevating the education system. According to Bagheri and Movahed (2017), IoT is a technology that allows Internet-based communication between physical objects and sensors. The introduction of the IoT has changed the environment of educational institutions on a massive scale. The integration of technology supports the changes in the education system, which emphasizes self-learning and teachers being facilitators in and out of the classroom. Al-Qozani and Aleryani (2018) stated that the implementation of education by combining technological elements increases students' confidence in dealing with teachers and classmates.

According to Aristovnik, Kerzic, Ravselj, Tomazevic and Umek (2020), the educational landscape has changed since the world faced the Covid-19 pandemic. The COVID-19 pandemic has caused the most extensive disruption of the education system in history, affecting nearly 1.6 billion students from 190 countries and all continents. As a result, school closures and the learning environment have affected 94 per cent of the world's student population, up to 99 per cent in the low- and lower -middle - income countries. On the contrary, the crisis has spurred innovation in the education sector (UNESCO, 2020). A study conducted by the United Nations Educational, Scientific, and Cultural Organization (2020) found a variety of innovative approaches to support the continuity of education and training practised among teachers in the face of this pandemic. For example, the implementation of teaching using radio and television. These changes also remind educators that there is a need for teaching approaches to ensure that students are stunted from accessing education.

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2. Significance and Objective

Muhammad Nawi (2020) stated that multimedia applications such as 2D, 3D and 6D animation and Virtual Reality facilitate teaching and learning activities. The use of educational applications like IoT and AI encourages students to learn how to use the latest technologies in education. This practice also helps teachers and students collaborate online and face-to-face learning. Salsidu, Azman and Abdullah (2017) found that developments in information technology have helped the education system make strides towards 21st-century education. So, this systematic survey is to identify peer-reviewed literature on the field of IoT and artificial intelligence in education through the Scopus and the Web of Science database. The research work precisely by summarized the research objective as shown in Table 1.

Table 1. Research question with its significance

Research Objective	Significance of research question
1. Analyse literature related to the use of Internet of Things and artificial intelligence in Education.	1. Contributed in identifying clusters that are frequently studied and be able to improve their related studies in the future.
2. Identify nature and scope of Internet of Things and artificial intelligence technology applications in education based on literature.	2. Using the PRISMA approach and Bibliometric methods to identify both technologies usage nature and scope in the field.
3. Analyse the impact of Internet of Things and artificial intelligence technology in education based on literature review.	3. Recommend the effectiveness of the use of technology in education, especially on student achievement and behaviour.

3. Literature Review

3.1 Antecedent of Internet of Things in education

The Internet of Things (IoT) is a technology that was sparked in 1999 by Kevin Ashton (Bakla, 2019). IOT is a technology that adopts a communication network with the surrounding objects through an internet connection. Narayan, Herrington, and Cochrane (2019) found that IoT in education has been absorbed directly into 21st-century education, requiring integrating technology in education according to global developments.

According to Aldowah, Ul Rehman, Ghazal, and Naufal Umar (2017), e-learning is among the first concepts absorbed in education with IoT technology. The use of e-learning has facilitated students as well as educators. E-learning at the tertiary level provides lecturers space to observe and provide all learning materials to students.

Al-Qozani1 and Aleryani (2018) introduced IoT technology in many educational institutions in security cameras, temperature control, access between buildings, and lighting. In addition, IoT provides many benefits to all groups, especially educators and students, in accessing teaching and learning activities without interruption online. The study's findings also improved the quality of assignment preparation and involvement in teaching and learning activities. However, IoT must maintain a balance between positive effects and provide awareness of risks to privacy and security (Marquez, Villanueva, Solarte & Garcia, 2016). Both educators and students need to understand ethical issues and IoT risks better and eliminate those risks. Personal and public data should be treated differently, and individual privacy should be respected and taken into account.

Whereas, according to Bagheri and Movahed (2017), IoT devices such as e-books, tablets, sensors, fitness gadgets, virtual and augmented reality devices are used in education today to track and monitor students in various aspects such as understanding student learning patterns. Smart classrooms help measure students'' level of interest by monitoring their behaviour using cameras and microphones. Additionally, Nurul'Ain Saffar Ullah, Ibrahim, and Bejau (2020) stated that teachers have a good understanding of the use of IoT through cooperative learning. Teachers use IoT technology by planning and implementing teaching activities. In addition, the behaviour IoT also helps in improving interpersonal and confidence to communicate.

With this, it can be concluded that IoT technology in education, even in Malaysia, is not new. This technology has already been widely used in education. However, its use is seen in administrative matters as well as equipment in educational premises. Again, the use of IoT in primary schools is deficient. So, developing an application with IoT technology can float this existing void. The level of use of IoT in education, especially in teaching and learning activities in primary schools.

3.2 Antecedent of artificial intelligence in education

According to Suparno (2019), artificial intelligence is a technology introduced as early as the 1955's. However, it is not easy to be absorbed into education. The UNESCO Annual Education Report (2019) peels back that these difficulties in accepting artificial intelligence in the school environment are inherent due to the difficulties experienced in identifying the elements that need to be absorbed from this technology. According to Albahri, Zaidan, Albahri, Zaidan, Abdulkareem, et al. (2020), artificial intelligence can help promote collaborative learning. One of the most compelling aspects of computer-supported collaborative learning is found in situations where students are not physically in the exact location. This gives students variable choices as to how far and where they want to study.

With applications developed with artificial intelligence techniques such as machine learning and superficial text processing, AI systems monitor discussion groups, thus providing teachers with information on discussion and student support to guide student engagement and learning (Zawacki-Richter, Marín, Bond & Gouverneur, 2019). Next, Chen (2018) found that in 2016, the Chinese Ministry of Education stipulated that every local education department must allocate at least 8% of its budget to digitise education. With 95% of schools connected to the internet, the country is poised for the world's largest digital education experiment. One of the biggest successes to date in China has been the experimental design to create an app that can correct essays using artificial intelligence techniques. The country began working with 60,000 schools for automated essay correction with a human-appropriate accuracy of 92%.

Ocaña-Fernández, Alex Valenzuela-Fernández and Lourdes Garro-Aburto (2019), noted that many educators have knowledge of artificial intelligence technology. However, educators are still worried or do not dare to integrate elements of artificial intelligence into teaching activities. Meanwhile, Goksel and Bozkurt (2019) state that although all countries have started using artificial intelligence in education, there is still a need to implement a policy to ensure its implementation is relatable. Finally, Tanveer, Hassan and Bhaumik (2020), the potential of artificial intelligence enhances the learning experience among students with disabilities. Thus, to be able to conclude that artificial intelligence is an inevitable technological element in education nowadays.

4. Research Methodology

A systematic literature review is desirable for research on this topic. PRISMA (Preferred Reporting Items for Systematic Review and Meta-Analysis) and Bibliometric analysis have been applied to answer the research questions. PRISMA method applied to shortlist and selects the 842 articles from Scopus and the Web of Science databases with explicit inclusion and exclusion criteria as below:

- The article period of 2014 to 2020
- The article focus on artificial intelligence in education
- Duplicate article with same author and topic removed
- Only articles published in English language

4.1 PRISMA approach

According to Sierra-Correa and Cantera Kintz (2015), the use of PRISMA will provide three advantages, namely:

1. Clearly defining research questions that require systematic review to be done,
2. Identifying criteria for inclusion or exclusion, and
3. Trying to see an extensive database of scientific literature at a given time.

So, the study used this approach to conduct a systematic review of the field of IoT and AI in education. The searches were run against the title, keywords, abstract of works in different databases discretely.
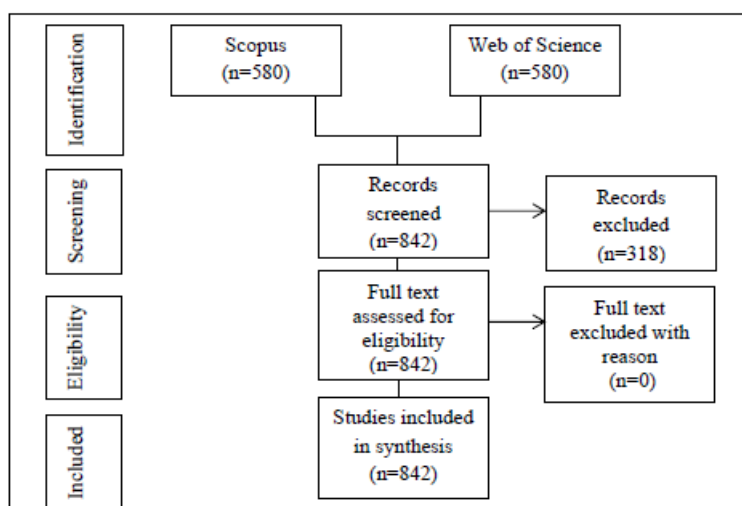
Figure 1. PRISMA flowchart for systematic review of IoT and AI

5. Bibliometric Analysis

Bibliometric analysis was conducted to analyse the nature and scope of IoT and AI in education. Bibliometric analysis carried out by filtering the article with keywords as in Table 2. In the first phase, bibliometric analysis is carried out by analysing keywords. A total of 10 keywords were identified and analyzed. In the subsequent stage, an analysis of the publication was conducted based on a cluster from

842 studies analysed. The following are the findings of the bibliometric analysis based on two phases:

5.1 Analysis of keyword

A total of five sets of keywords were used in determining the study through the Scopus database and the Web of Science. The primary keyword used is artificial intelligence and teaching. While the secondary keywords used are model and development. The keywords used in bibliometric analysis on IoT and AI are depicted in Table 2. In which the set of keywords are used with the "AND" or "OR" operator.
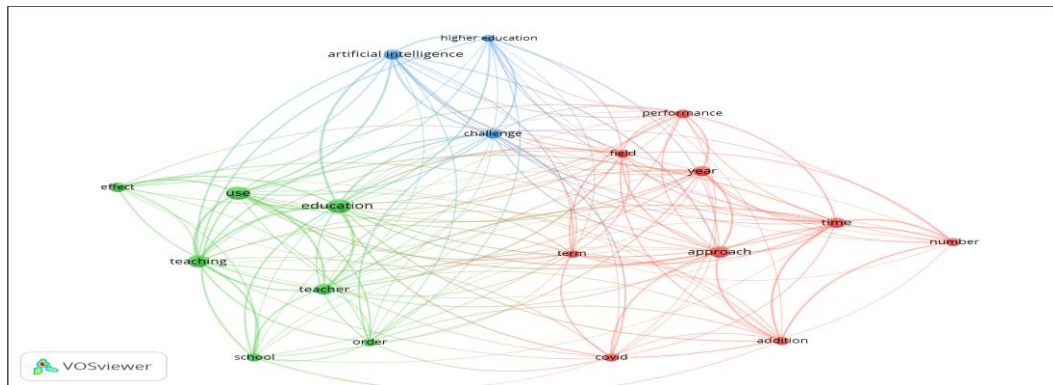
Table 2. Initial search string

Keywords set	Keywords	Occurrences	Relevance
Keywords_Set1	""artificial intelligence" OR "artificial" OR "AI" OR "applicability"	40	2.19
Keywords_Set2	"model" OR "computer graphic" OR "computer" OR "graphic"	45	1.26
Keywords_Set3	"teaching" OR "software" OR "development" OR "animation" OR "internet"	80	2.10
Keywords_Set4	"game" OR "education" OR "challenge"	54	0.70
Keywords_Set5	"higher education" OR "teaching tool" OR "trend"	79	0.98
Keywords_Set6	"Internet of Things" OR "IoT"	112	1.56
Keywords_Set7	"Trend of IoT" OR "Uses of IoT" OR "Adoption IoT"	52	0.86
Keywords_Set8	"Acceptance of AI" OR "Acceptance of IoT" OR "Acceptance of Technology"	28	0.66
Keywords_Set9	"Benefits of AI in Education" OR "AI Benefits Students" OR "IoT Benefits Students"	20	1.37
Keywords_Set10	"Challenges" OR "Implementation" OR " Opportunities"	202	2.32

5.2 Analysis of cluster Internet of Things in education

A total of 842 studies were analysed through VOS viewer, and the finding showed that the use of IoT technology in education is still not much focused on teaching and learning. Building and security clusters and sensory hardware were central to the literature review analysed. Figure 2 shows the 24 significant clusters identified that became the trend or nature of using this technology in education.

Figure 2. Analysis based on cluster in IoT

Figure 3. Analysis based on cluster in AI

Figure 4. Analysis based on abstract and title of publication

5.3 Analysis of cluster artificial intelligence in education

Next, all 842 studies were entered into the VOS viewer software to analyse information about the clusters or trends of the studies conducted. As Figure 2 and Table 3 show a total of three clusters have been identified.

Table 3 shows the items for each of the identified clusters. With this analysis, the second research question is answered, namely, the research trend or nature shows that most of the research is conducted in the development of artificial intelligence models and software. Also shows research trends related to animation and computer gaming using artificial intelligence technology. Overall, research trends cover the field of artificial intelligence and education as well as the challenges of its use.

Table 3. List of all clusters

Cluster	Items
Cluster 1	Artificial Intelligent, Challenge, Computer Graphic, Development, Higher Education, teaching
Cluster 2	Animation, applicability, computer, game, internet
Cluster 3	Application, model, software

6. Discussion

This systematic survey using PRISMA and bibliometric methods has answered three research questions developed. First, in total, 842 studies published in Scopus and the Web of Science were analysed. A total of ten sets of keywords were published in screening the content of the study. Second, bibliometric analysis has provided an overview of IoT and AI's effects in education on students. Overall, there are many studies conducted related to the use of IoT and AI in education. Usage trends show that most studies are related to developing applications and software and IoT and AI models in education. Also, the trend shows studies related to the development of gaming applications in education. According to Albahri, Zaidan, Albahri, Zaidan, Abdulkareem, et al. (2020), AI can help promote collaborative learning. One of the most compelling aspects of computer-supported collaborative learning is found in situations where students are not physically in the exact location. With applications developed with artificial intelligence techniques such as machine learning and superficial text processing, artificial intelligence systems monitor discussion groups, thus providing teachers with information on discussion and student support to guide student engagement and learning (Zawacki-Richter, Marín, Bond & Gouverneur, 2019). Finally, Tanveer, Hassan, and Bhaumik (2020), the potential of artificial intelligence enhances the learning experience among students with disabilities. The rapid development of automation with the use of IoT and AI technology shows that the world of education in particular needs to adapt for the program's survival and the graduates it produces to remain competent and ready to face the current Industrial Revolution 4.0 with complete preparation. In this regard, to stay intense and competitive, thorough preparations must be made for educators to face this challenge. Extensive exposure to the teaching staff can increase awareness and knowledge of the Industrial Revolution 4.0. With this, education transformation can be implemented through teaching and learning methods in meeting the challenges towards the Industrial Revolution 4.0.

7. Future Work

Studies on the use of IoT and AI technology in education through systematic literature review and bibliometric meta-analysis show some recommendations in the future:

- Studies related to the effectiveness of the use of artificial intelligence technology in education show inadequacies. Therefore, there is a need to increase research related to the effectiveness of the use of technology.
- This review also shows the nature of usage IoT and AI, but research related to the combination of IoT technology and artificial intelligence is still lacking.
- The use of IoT and AI also needs to be coordinated with Industrial Revolution 4.0 with 21st-century education.

8. Conclusion

This systematic review shows an increase in studies related to the use of IoT and AI in education. This increase shows starting from 2014 to 2020. Most of the studies conducted are related to the development and use of these two technologies in education. Next, the style of use of these two technologies shows two different perceptions. First, IoT shows its use is limited to the security and maintenance of educational institution buildings. Al-Qozani1 and Aleryani (2018) noted that the use of IoT maintains a balance between positive effects and provides awareness of risks to privacy and security. A total of 842 studies reviewed in this systematic review have explored room to develop applications or software that can integrate into teaching and learning activities using IoT and AI technologies.

Moreover, using these two technologies in education has become something that is not new and difficult to practice. According to Goksel and Bozkurt (2019), teachers have the knowledge and skills in handling these two technologies in education. Through this systematic review, it can be concluded that the development of applications and instructional materials using these two technologies should be intensified in line with 21st-century educational practice.

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