

A Systematic Review on Artificial Intelligence in Education (AIE) with a focus on Ethics and Ethical Constraints

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Abstract

The increased use of Artificial Intelligence (AI) based applications in our daily lives, not only influence the way we live but also inspires pedagogical practices in education. This study showcases how artificial intelligence helps in the improvement of teaching, learning and pedagogical processes in educational settings and the importance of ethical aspects related to Artificial Intelligence in Education (AIEd). A systematic review (SR) based on the protocol Preferred Reporting Items for Systematic Review and Meta-Analysis (PRISMA) of AIEd in the last nine years (2013-2021), restricted to two databases (Web of Science and Scopus), has been conducted. The major focus is on ethics and ethical constraints faced by the users of AIEd. The search key terms for the review are “Artificial Intelligence in Education” (AIEd), “Artificial Intelligence in digital ethics”. The non-English and in press articles have been excluded. After a careful assessment of each record based on the objectives and scope of the SR, 32 research articles are shortlisted to be included. Further research on the study is done through bibliometric analysis based on co-occurrence of keywords with country-based and citation-based using VOSviewer software. A comparative analysis of segments was used to understand the ethics in AIEd. The result highlighted two prominent factors for further research in AIEd; the specification of “Digital Ethics” and “Potential Research areas in the implementation of AIEd’s ethics”. The current systematic review has comprehensively expressed the opportunities and capabilities of integration of AIEd within the chosen databases and timespan of nine years.

Keywords: Artificial Intelligence in Education, Digital Ethics, Artificial Intelligence and Ethics, PRISMA, Systematic Review

Introduction

Artificial Intelligence in Education (AIEd) is the efficient way of using technology in education. One method for characterizing Artificial Intelligence (AI) are those interactive computer systems intended to associate with individuals through human-like behavior for instance verbal communication (Luckin et al., 2016). AI usage is increasing in every field of daily life (Lee, 2020). Similarly, the use of Open AI has greatly enhanced the capacity of researchers studying in the field of AIEd. Methodologies involved in building AI systems in education are machine learning, computer modeling, data mining, and probability statistics. AIEd is based on an adaptive learning environment that utilizes all aspects of AI in the form of AI systems that are personalized, inclusive, engaging, and effective (Luckin et al., 2016). AIEd is fundamental in the adoption of 21st-century skills such as tech literacy, adaptability, communication, and leadership (Chaudhry & Kazim, 2021).

The term of AIED was first introduced in the 1980s as the advancement of technology ushered into the educational sector (Chong, 2020). Technological advancement in education enabled teachers perform their jobs more efficiently and effectively, for instance, Turnitin for plagiarism detection in assignments and thesis can be traced easily with AI efficient sources (Chen et al., 2020). AI is making considerable changes in education including the familiar uses of adaptive and personalized learning environments as well as new developments in robotic teachers, which are transforming the education system (Holmes et al., 2019).

Elliott (2019) highlighted daily human interaction with AI in multiple ways. AI in the form of virtual assistants is commonly used around the world for instance Google Duplex, Alexa, Siri. Google search engine uses AI to curate the appropriate resources for our search. JP-Morgan Chase's Contract Intelligent Form uses machine learning, AI learning, and image recognition software for the analysis of legal documents. Papers can be reviewed within seconds as compared to manual reviewing which takes lots of hours. IBM Watson for medical diagnosis especially with rare leukemia. Google AI Eye Doctor can examine retinal scans and diagnose diabetic retinopathy, one cause of blindness. NETFLIX recommendations are based on 70% of visitor's watched history .

Literature Review

Types of AI

There are three basic terms to distinguish AI at the domain levels. First level is Narrow or Weak AI (which focuses on a single task) this is the level which we achieved today in AI, comprised of a narrow or weak range of abilities which include diagnostic machines in the health sector, self-driving cars, speech recognition, etc. (Long & Magerko, 2020). The second level is the General AI or Strong AI which is smart and comparable to human abilities. Strong AI has capabilities closer to human beings and can perform the way humans can perform on multiple tasks. Strong AI includes reinforcement learning which is a powerful approach similar to human learning (Luckin et al., 2016). For instance, the discovery of the Alpha Go game, which learns all paths of the game just like human beings. Similarly, Strong AI was used in the discovery of the "ORF 8" protein of Corona Virus, which led to Covid 19 vaccine (Luckin et al., 2016). The last level is Super AI which has capabilities that exceed those possessed by human beings, Super AI is yet to be achieved (Zawacki-richter et al., 2019).

Working of AI systems

AI is engineering with data collection and algorithms. AI algorithms and programming are comprised of software that works on machine learning. Machine Learning (ML) is the core part of a working AI system, where algorithms are used to build increasingly accurate models from data and these models are also helpful for decision making in the specified work fields (Long & Magerko, 2020). ML is at the lower level of AI and solves the three kinds of problems; regression, classification and clustering (Nti et al., 2021). Algorithmic calculations are the arrangement of rules and measurable methods used to gain the example from information. A model is prepared by utilizing AI calculations. The Predictor Variable is the component of the information that can be utilized to anticipate the result. Response Variable is the element that yield variable that should be anticipated by utilizing the indicator variable. Preparing information is utilized to prepare the model is called Training Data, where Testing Data is utilized to determine the effectiveness of the model. ML is further based on Deep Learning (DL) which consists of major AI such as decision-making for predictions etc. (UNESCO, 2019). DL is the logical subdivision of machine learning, and is comprised of

inductive logic programming, decision tree learning, clustering reinforcement learning and Bayesian network as learning networks and types of models, this is defined as neural networks (Zawacki-Richter et al., 2019).

The research question of this systematic review is “What are the important concepts of ethics which are related to AIED?” Researchers have different opinions on the current situation and to date are trying to solve the situation through different routes in the field of AIED. The current study aimed to analyze the research published on the AIED, Ethics and Educational integration. This SR helps to understand the integration of AI in education concerning ethics. The year-wise increase in literature has been mapped to understand the research of AIED and important ethical aspects for the learners, teachers, and institutes.

Methodology

A Systematic review is carried out for this research study based on organizing an examination region and distinguishing gaps in information (Petersen et al., 2015). An attribute of SR is responding to general exploration questions that seek to establish research patterns. Systematic mapping studies have been involved by numerous specialists in this field of AIED (Dicheva et al., 2015; Farshchian & Dahl, 2015; Marques et al., 2020; Pelanek, 2020). PRISMA framework methodology is used in the searching of articles during the SR of the literature. PRISMA is a set of evidence-based minimum items for reporting in Systematic reviews and Meta-analysis (Moher et al., 2009). The scoping method is used to extract the relevant articles on AIED by utilizing a search method to target the relevant literature in the educational domain.

Searching Strategy: Researchers developed a search strategy for this SR consisted of two databases “Web of Science” and “Scopus”.

Keywords: The keywords being important used for this SR. The keywords researcher used for the systematic review are “Artificial Intelligence and Ethics”, “digital ethics for education” and “Systematic reviews of AIED”. Search is done using only Boolean operator of AND is “Artificial Intelligence in Education” AND “Ethics”. More than 5 attempts were made on each database of Scopus and Clarivate for the research. The keywords used for the research were tried with and without quotes to get the matching results on both data bases.

Record extraction: The article search was refined utilizing predefined consideration and rejection models and quality norms. Each channel guaranteed quality principles. In the systematic review, included articles published from 2017-2021 in the field of AIED & ethics are included.

Screening: Upon review of our data, the research window was expanded to include publications from 2013-2021. Review papers, journal articles, research reports and conference papers published in the English language only have been included for this SR depending upon the PRISMA statement (Moher et al., 2009). The SR focused on publications on AIED primarily in the fields of sciences and training. The total number of articles extracted from databases was 254, which was then shortlisted by inclusion and exclusion criteria to a list of 32 articles used in this inquiry study.

Inclusion criteria:

- All published articles, review papers and conference reviews are included.
- The selection of databases is the Scopus and Web of Science SSCI.

- All articles are included published from the year 2013 to 2021.
- Articles are included in the SR are limited to certain fields of sciences including computer science, social science, engineering, mathematics, decision sciences, arts and humanities and environmental sciences.
- Only English language publications are included.

Exclusion criteria:

- Unpublished articles, review papers and conference reviews
- Publications, not found in the Scopus and Web of Science SSCI databases
- Articles published before the year 2013 and published after 2021
- Articles in the subject areas of medical sciences, economic, econometrics, and finance
- Non-English language publications.

Selection of articles: The following SR is based on the original research articles, review papers, conference papers, and research reports in the final publication stage. For the examination and decontamination of the articles, abstracts of the articles were checked carefully to guarantee the quality and pertinence of the scholastic writing remembered for the survey cycle. After the screening process, it was found that 79 articles are not related to the specific field of AIED and ethics. So, applying exclusion and inclusion criteria the total articles reviewed produced a list of 32 articles that fit the criteria for this study. The information was then exported to Excel for investigation of the precise audit. Figure 1 shows PRISMA statement implementation in this review after careful evaluation of the documents and research tables. Further bibliometric analysis was conducted on the data extracted in the Excel worksheets. Bibliometric investigation is a famous writing examination strategy that gives a quantitative appraisal and assessment of scholarly outlets in a specific area of study (Chen, Zou, Cheng, & Xie, 2020).

Quality Evaluation: This systematic review includes published and original papers to providing a balanced review of the current literature on AIED. Results, Abstract, and Conclusion were isolated to restrict the filed. Moreover, the reference section of publications included in this study were subjected to the inclusion and exclusion criteria to determine if these cited publications should be included in this study. The records were carefully reviewed to eliminate duplication and ensure all publications included accurately fit the nature of the survey.

Qualitative Synthesis: In the wake of choosing the included publications, analysis of the data consisted of two simultaneous activities, in the examination performed on chosen papers. First, the metadata was imported into Microsoft Excel to investigate AIED Ethics writing for example subjective examination and meetings hung regarding the matter of AIED and Ethics. Second, content examination is performed to arrange and analyze key examination streams announcing late exploration across assorted subjects and accentuating expected issues and opportunities for impending review. Content examination is an exploratory method to decompose text to examine the content allowing researchers to group data in an efficient strategy, providing replicable and valid examination of texts.

PRISMA statement for literature exclusion and inclusion at every stage:

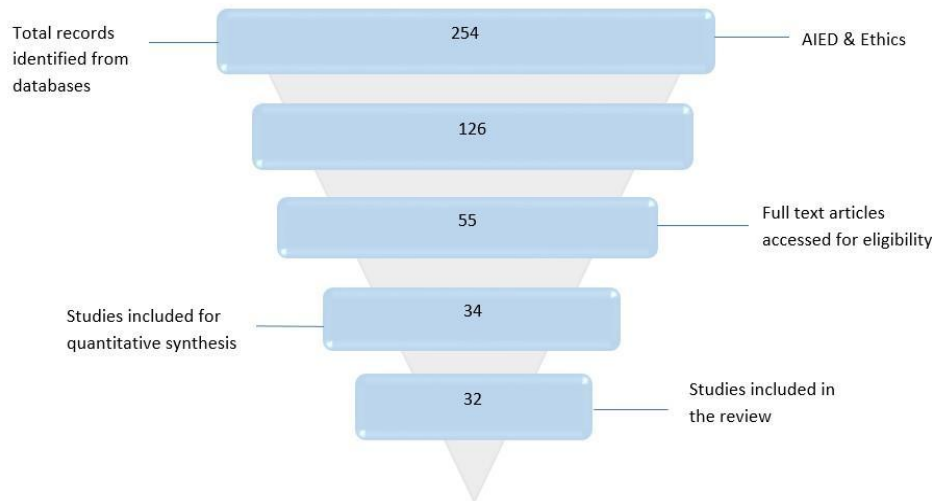


Figure 1: PRISMA statement implementation in review

Table 1: Most cited articles included in study

Author	Title	Year	Source title	citatio ns
Zawacki- Richter O., Marín V.I., Bond M., Gouverneur F.	Systematic review of research on artificial intelligence applications in higher education – where are the educators?	2019	International Journal of Educational Technology in Higher Education	181
Kay J., Reimann P., Diebold E., Kummerfeld B.	MOOCs: So many learners, so much potential.	2013	IEEE Intelligent Systems	158
Roll I., Wylie R.	Evolution and Revolution in Artificial Intelligence in Education	2016	International Journal of Artificial Intelligence in Education	152
Timms M.J.	Letting Artificial Intelligence in Education out of the Box: Educational Cobots and Smart Classrooms	2016	International Journal of Artificial Intelligence in Education	101
Johnson W.L., Lester J.C.	Face-to-Face Interaction with Pedagogical Agents,	2016	International Journal of Artificial Intelligence in Education	96

	Twenty Years Later			
Bull S., Kay J.	SMILI: A Framework for Interfaces to Learning Data in Open Learner Models, Learning Analytics and Related Fields	2016	International Journal of Artificial Intelligence in Education	81
Chen X., Xie H., Zou D., Hwang G.-J.	Application and theory gaps during the rise of Artificial Intelligence in Education	2020	Computers and Education: Artificial Intelligence	70
Hwang G.-J., Xie H., Wah B.W., Gašević D.	Vision, challenges, roles and research issues of Artificial Intelligence in Education	2020	Computers and Education: Artificial Intelligence	64
Chen L., Chen P., Lin Z.	Artificial Intelligence in Education: A Review	2020	IEEE Access	62
Alyahyan E., Dü?tegör D.	Predicting academic success in higher education: literature review and best practices	2020	International Journal of Educational Technology in Higher Education	57
Luxton D.D.	Recommendations for the ethical use and design of artificial intelligent care providers	2014	Artificial Intelligence in Medicine	53

Results and Findings

Figure 2 depicts of the last nine year's data, the number of publications per year on AIED in the setting of ethics. Figure 2 demonstrates the rising trends of educational awareness in the ethical areas. Although Artificial Intelligence field is an accepted area of study globally, ethics in AIED is relatively underdeveloped concept. The increase in the research over the 2018-2021 time frame depicts an exponential rise in publications in AIED ethics. Figure 2 shows the greatest number of publications in AIED ethics is made in the last two years.

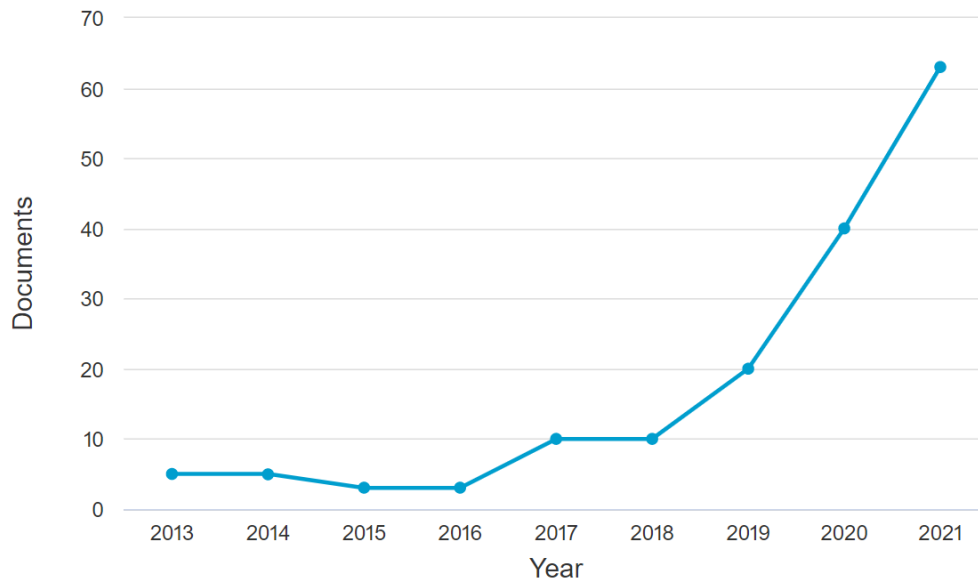


Figure 2: Distribution of AIED and ethics published documents from 2013 to 2021.

Figure 3 is extracted from Scopus analysis of the results. Figure 3 illustrates the participation of the countries involved in the research of AIED and Ethics. According to the graph the majority of AIED and Ethics research has been conducted in the United States in the past nine years. Second to the United States is the United Kingdom, where considerable research is taking place in the ethical context of AIED. Australia, China and Germany are also following the trend in AIED. Russian Federation and many European countries are also participating in the new field of AIED and Ethics.

Compare the document counts for up to 15 countries/territories.

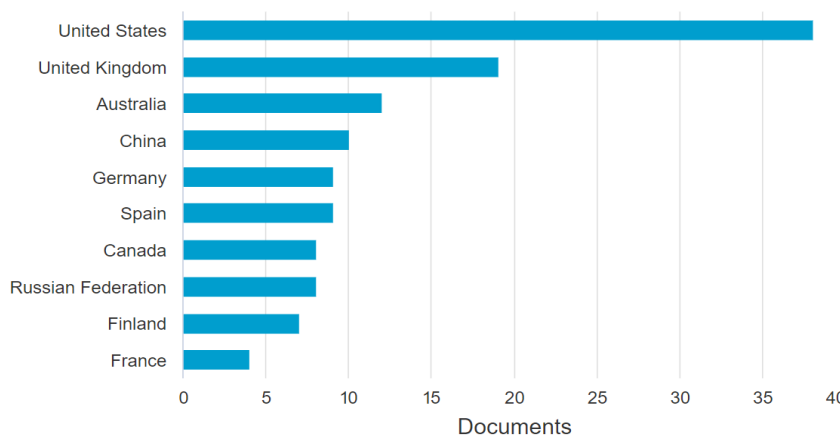


Figure 3: Countries doing research in AIED & Ethics 2013 to 2021

According to Figure 4, the maximum number of citations can be seen in the recent articles and research. The data of the last five years show a considerable increase in the citation of the articles. From 2016, onward we can see an increasing trend in the cited articles. The citation in AIED increased rapidly in 2020 and 2021 showing the maximum research in AIED's ethics.

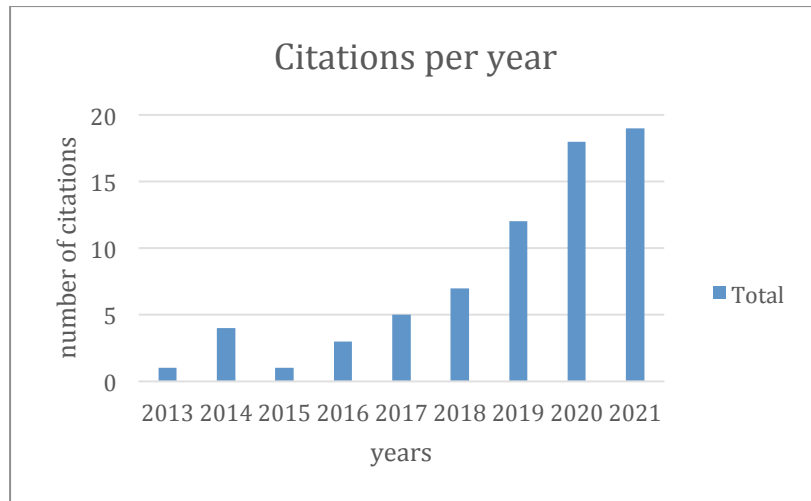


Figure 4: Number of citations from 2013 to 2021

Data extracted for a systematic review is from Web of Science and Scopus databases and according to the Scopus findings, Figure 5 shows the types of documents written from 2013 to 2021. According to Figure 5, it is clear that the preponderance of publications were conference papers on ethics. So, AI ethics was considered the most important field in the current tendency of education and pandemic. The other reason for the large number of conference papers, could be that with the increased digitization of society, there is a growing understanding of the need for basic knowledge in the educational ethics. The second most common type of publication are journal articles written in the AIED's Ethics. Apart from conference papers and articles research is done in the form of review papers, conference reviews and books are also written on AIED's Ethics.

Documents by type

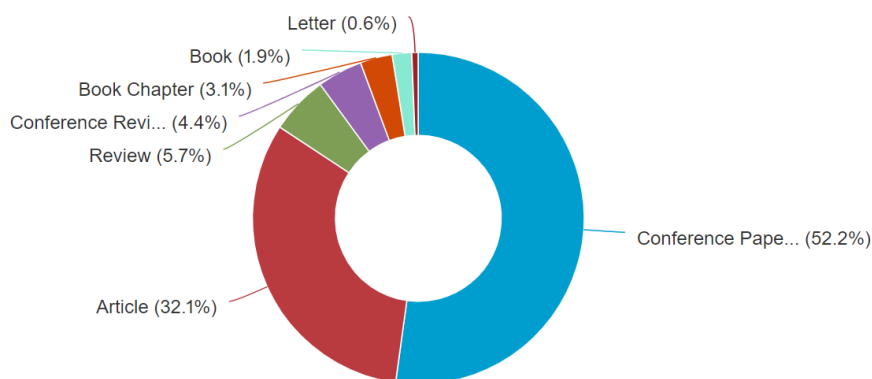


Figure 5: Types of documents data from 2013 to 2021

In the SR process, we also analyze the areas of focus in all articles, conferences and research papers. There are specific fields in which most of the papers are written for example AI & Ethics was the major focus of many research papers. From Figure 6, we can access that the major area to be discussed in the ethics field is the ethical challenges. Ethical challenges includes privacy, security, transparency, and confidentiality. Many other concepts are also

being discussed including ethics education, user autonomy, ethical & moral behavior and ethics involved in the teaching and learning process.

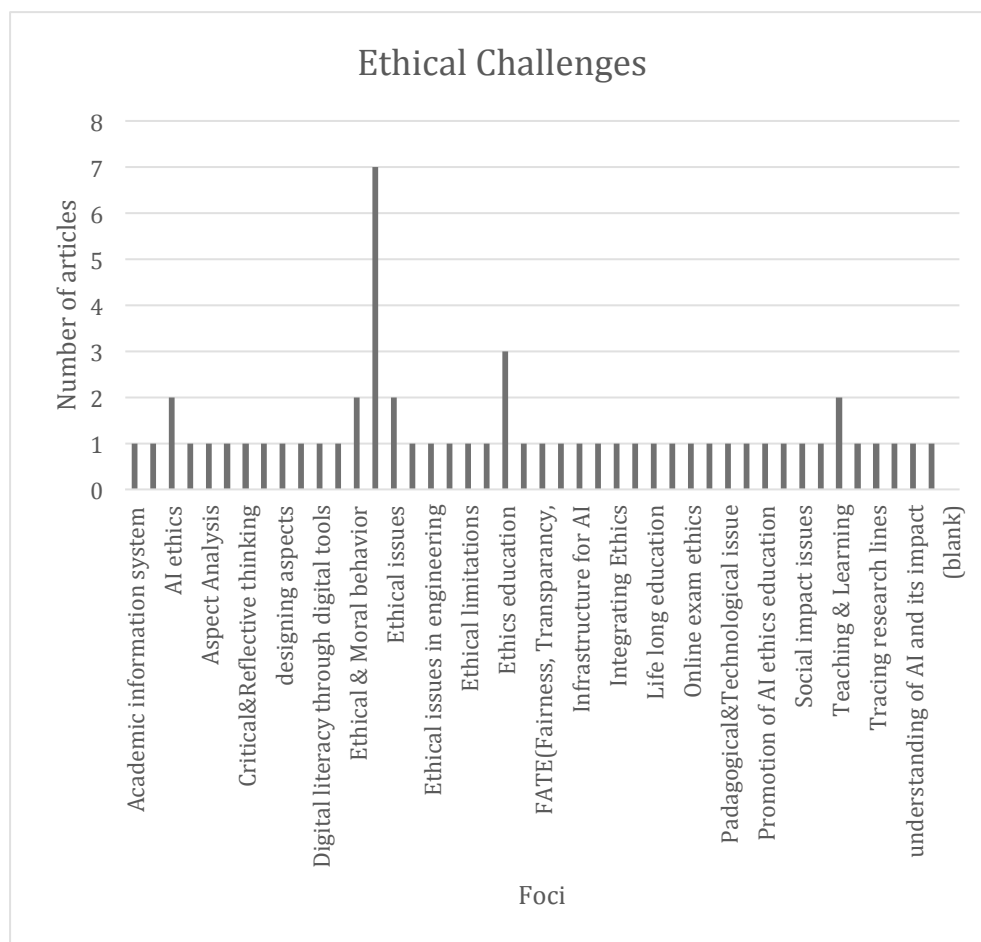


Figure 6: Focus of articles & Conference papers on AIED & Ethics

Classification of literature based on Artificial Intelligence in Education and Ethics:

The publications included in this review were analyzed further by content analysis. VOSviewer software enhances the analysis published articles data by illuminating the connections between publications. With the help of linked concepts, data is presented in the form of networks based on information included in the text. As data from multiple publications is included in the visualization, different networks accumulate into clusters. This analysis used author keywords from publications included in this study. The bibliometric analysis was conducted using data from the Scopus and WoS extracted into an Excel files. A total number of 144 records were added in the review which include 1302 keywords. From these 1302 keywords, 52 keywords meet the threshold for inclusion in the visualization. After careful refinement of the keywords, the minimum occurrences of a keyword in the document is kept as 5. So, the research includes a total of 35 keywords, having the total strength of co-occurrence linked with other keywords. The network shows five major clusters. The red cluster focused on the area of AI and related concept of machine learning. The green cluster shows two interrelated major foci due to similarity in keywords, these are ethics and philosophical aspects. The blue cluster is associated with engineering education and technological sub concept. While the human factor is shown in yellow color. The last one is the purple cluster based on educational concepts.

education (Luan et al., 2020). AI areas related to search include common aspects in learning like purpose, pedagogical choice, role of technology concerning teachers and learners (Holmes et al., 2021).

Artificial Intelligence in Education and Ethics:

The concept of AIED and ethics originated almost two decades ago. Aiken and Epstein pioneered this concept, when they published an article on Ethical guidelines for AI in Education (Latham, Annabel & Goltz, Sean, 2019). Ethical aspects related to the curriculum were always a primary consideration of the educationists but AIED and Ethics were first discussed by the experts in the "Beijing Consensus" conference held by UNESCO in China (Xu, 2020). According to Beijing Consensus, it is time for consideration of ethical issues in AIED. Technological integration is increasing in education computer programming of AI in education so, it is required by the software developers to formulate the digital ethics (Chaudhry & Kazim, 2021). For ethical integration in the educational technology it is preferred either to integrate ethics in existing courses of software development or to introduce stand-alone courses of ethics in computer science (Garrett et al., 2020). The important thing to be considered is the data confidentiality for the AI users because when everything is in the control of the expert system or AI software then there is an issue of data privacy and protection therefore the area of ethics in AI is established to address these issues (Zawacki-richter et al., 2019). During the last decade, there has been an increased number of research studies in AIED. This research brought highlighted several innovative technologies for education systems in the form of Applications, Software, online Learning Databases, Learning Management System (LMS), and Intelligent Tutoring System ITS (Chong, 2020). Well-designed ITS are able to complete the tutoring task at all educational and cognitive levels (Dermeval et al., 2018). These advancements are seen as revolutionary in the learning institutes however, there are some issues associated with the ethical perspectives of these new technological devices and software technological advancement (Chaudhry & Kazim, 2021).

Research Collaboration of different countries in “AIED & Ethics”

Figure 8 shows 144 records in total, being added in the analysis. Out of 47 countries, 29 meet the threshold as the minimum number of documents included from the country is 2. The countries with the greatest total link strength will be selected. Following correlation of the countries is found. This correlation shows that maximum research is done in the United States, which collaborates with many countries for the finding the latest trends in Artificial intelligence in education and ethics field. The network shows four major clusters of the regions. Green color includes the United States playing a central role in research with the Russian Federation, Australia, United Kingdom, China, Canada and Ireland. The second important cluster is centered on United Kingdom showing collaboration with the United States, Ireland, Spain and Finland. European countries are divided into two clusters.

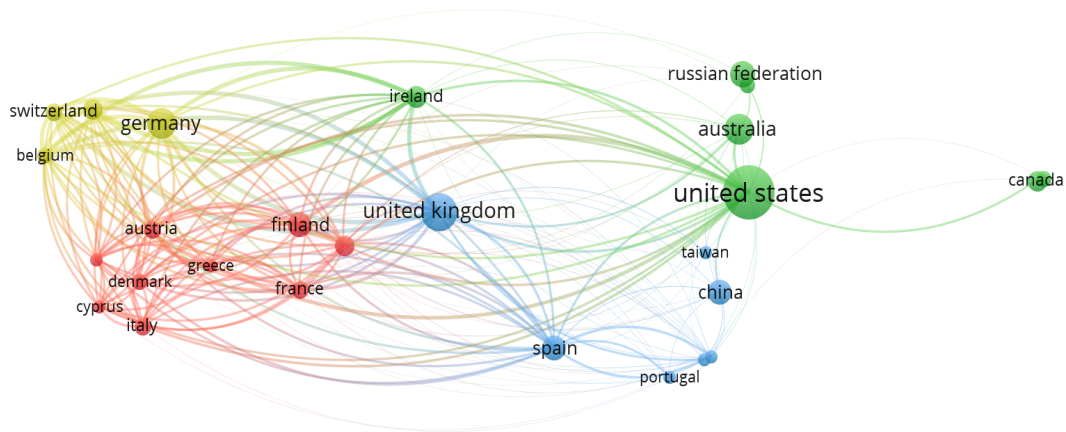


Figure 8: Research collaboration of countries on AIED's and Ethics

Conclusion

The area of our research is focused on finding the ethical constraints related to AIED. The findings were generated by conducting the systematic review of the literature on “AIED and Ethics” from 2013 to 2021. Ethics in AIED is the most current topic in AI integration in education. AI integration mutually empowers teachers and students (Luckin et al., 2016). AI integration in education is expected to continue for the foreseeable future. AIED is helpful for the teacher to automate the repetitive tasks by reducing burdens during pedagogical practices. Meanwhile, the students are getting benefits of a personalized and individualized environment for education (Liang & Tao, 2020). At the same time, the integration of AIED brought many ethical risks and challenges in education. Concluding from the literature First, the area which needs to be addressed is the ultimate “decision making” will always be prerogative of the humans. The AI algorithms are making life decisions for humans which is morally and ethically unacceptable for humans (Borenstein & Howard, 2021). AI systems should work as the utility for humans just like the case of recommendation engines, but these systems should not be allowed to supersede humans, the other area which needs to be addressed is the Ethical design & Framework for AIED (X. Chen et al., 2020). This design requires the collaboration of educationists and software developers all around the world to make ethical algorithms to be used for AIED (Bawack et al., 2021). Other findings on the study of the literature showed that for sorting ethical problems in AIED, an important area is to devise a regulatory policy for “Data Ethics” to standardize legal and illegal data (Borenstein & Howard, 2021) ranking it as the core consideration in AI. The significant terms associated with ethical challenges and data are quite vast. For instance, Data security, Data reliability, Data transparency, Data authenticity and Data regulatory (Holmes et al., 2021). As per literature findings, “Biases” are also playing a crucial role in the ethical concerns of AI in the education field. As we know 80 % of AI is based on the training data (Chen et al., 2020). When the system learns these biases during training then the tools and applications will have inherent biases in them. Some critical types of biases are racial bias, gender bias, cultural bias, language bias and data interpretation bias (Chong, 2020). Literature reviews also suggested that educators and software experts should work to develop a curriculum based on “ethically designed courses”. The curriculum should be based on the modular approach for the courses of ethics based on AIED (Furey & Martin, 2019). These courses will consider all the regulations of ethics and machine-level ethical algorithms. For future research recommendations, it is necessary to have experimental research based on the implementation of ethical solutions. Since the majority of the systematic reviews were focusing on the trend line and norms in the research field of AIED,

there lacks a theoretical perspective for not concentrating on this specific field AIED and Ethics. It is suggested that future research is aligned to explore research in the implementation process of AIED and Ethics courses. Practical aspects of the ethical constraints will be revealed during the implementation phase of ethical courses.

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