sustainability

MDPI

Article

Research Status and Challenges on the Sustainable Development of Artificial Intelligence Courses from a Global Perspective

Ying Yang [1,*], Jinruo Qin [1], Jing Lei [2] and Yanping Liu [1]

[1] College of Education, Shaanxi University of Science and Technology, Xi'an 710021, China; bruceqin362@163.com (J.Q.); lyp103950@163.com (Y.L.)
[2] School of Foreign Studies, Shaanxi University of Technology, Hanzhong 723001, China; 15191646462@163.com
* Correspondence: yangysust@163.com

Abstract: The widespread application of artificial intelligence technology in various fields has made the sustainable development of artificial intelligence courses an important direction in the field of artificial intelligence education and teaching. Therefore, it is particularly important to conduct an in-depth analysis of the current research status of "artificial intelligence courses" from a global perspective. Firstly, this article clarifies the three stages of slow development, rapid development, and mature development of artificial intelligence curriculum research through the number and distribution years of the literature. It also conducts a co-authorship analysis on the distribution of countries, institutions, and authors of artificial intelligence curriculum research and identifies countries, institutions, and core authors that have made greater contributions to artificial intelligence curriculum research. Secondly, due to the involvement of artificial intelligence in many different fields of knowledge, an analysis is conducted on the journals that published papers on artificial intelligence courses. Finally, based on the analysis of keyword density and time span, the current research hotspots of artificial intelligence courses are summarized: artificial intelligence technology empowerment courses, two education directions at different stages of artificial intelligence courses, and teaching forms in the field of artificial intelligence courses. The current research trend of artificial intelligence courses is analyzed from three aspects: teaching format, teaching content, and teaching objects. This article provides a theoretical reference value and practical basis for future research and development in the field of artificial intelligence courses, while also providing experience for the efficient and sustainable development of artificial intelligence courses to a certain extent.

Keywords: sustainable development; artificial intelligence courses; pedagogy; knowledge graph; deep learning; future learners

Citation: Yang, Y.; Qin, J.; Lei, J.; Liu, Y. Research Status and Challenges on the Sustainable Development of Artificial Intelligence Courses from a Global Perspective. *Sustainability* **2023**, *15*, 9335. https://doi.org/10.3390/su15129335

Academic Editors: Aviral Kumar Tiwari, Teena Bharti and Nidhi Mishra

Received: 26 April 2023
Revised: 19 May 2023
Accepted: 2 June 2023
Published: 9 June 2023

1. Introduction

Artificial intelligence (AI) is the core driving force leading a new round of technological revolution and industrial innovation and has become a new trend for countries to use to accelerate development and keep up with world trends in the fields of education, healthcare, transportation, agriculture, and industry [1–4]. In order to accelerate the continuous exploration and application of artificial intelligence technology in various fields, countries around the world have formulated plans for the development of artificial intelligence, incorporating artificial intelligence technology into teaching curriculums in higher education and even primary and secondary education [5,6]. Therefore, international reports on the sustainable and high-quality development of artificial intelligence education frequently appear, and the emergence of these high-quality reports is sufficient to illustrate the impact of artificial intelligence on human sustainable development. The purpose of these reports is to promote innovation and the development of artificial intelligence in the field of education and achieve a wider application of artificial intelligence technology in

various sectors of society [7,8]. For example, in 2019, the European Union released The Impact of Artificial Intelligence on Learning, Teaching, and Education, which elaborated on what artificial intelligence is, its impact on learning, teaching, and education, and policy challenges [9]. In addition, the Organization for Economic Cooperation and Development (OECD) released Trustworthy Artificial Intelligence in Education: Promises and Challenges, in 2020, which pointed out the importance of AI in education and skills in the digital era, illustrating the importance of artificial intelligence education and how to better teach AI technology to students for the benefit of groups with relevant skills related to artificial intelligence. AI should be used to better promote the sustainable development of human beings in the future [10].

The current understanding of the AI curriculum can be summarized into the following three definitions. As a technical means, artificial intelligence technology promotes curriculum teaching based on technologies, such as intelligent perception, teaching algorithms, and data decision-making, making the education and teaching process more personalized and efficient [11–13]. Artificial intelligence technology is regarded as the teaching content of the course, which focuses on the learning and acquisition of artificial intelligence, including artificial intelligence knowledge education, application ability education, and situational education [14,15]. The course content for teaching artificial intelligence at different educational stages has a different emphasis. In February 2022, UNESCO released the report K-12 AI Curricula: a Mapping of Government-endorsed AI Curricula, which not only describes the development framework of AI basic education but also determines the global tone of the AI basic education curriculum [16]. It focuses on the deep integration of artificial intelligence technology and curriculum content, which means that the artificial intelligence curriculum not only includes the implementation of artificial intelligence to promote curriculum teaching but also includes artificial intelligence curriculum teaching so as to achieve the unity and integration of learning and application levels [17–19].

Therefore, this paper focuses on the deep integration of artificial intelligence technology and course content, focusing on how to teach students artificial intelligence technology as the course itself when using artificial intelligence technology for course teaching in order to cultivate students' key abilities to adapt to the development needs of the intelligence era. There are many research results on artificial intelligence technology and how it is used to promote education [20–24]. However, there are relatively few research papers focusing on artificial intelligence technology as educational content itself and how to deeply integrate artificial intelligence with curriculum content. On the contrary, artificial intelligence technology, including machine learning, deep learning, natural language processing, data mining, image recognition and processing, computer vision, and other technologies, is a key factor in national competitiveness [25–28]. Therefore, it is particularly necessary to teach students artificial intelligence technology as the content of the course itself when using artificial intelligence technology for curriculum teaching and to cultivate students' key abilities to adapt to the development needs of the intelligent era. At the same time, theoretical knowledge, educational core knowledge, and teaching design of artificial intelligence courses also need to be continuously studied in-depth. Therefore, from a global perspective, this study conducts an in-depth analysis of the literature on artificial intelligence courses collected by the Web of Science over the past 10 years. By showcasing the keyword knowledge graph of relevant literature on artificial intelligence courses, the current research hotspots and future research trends of artificial intelligence courses are analyzed from the perspective of critical density and time span so as to provide direction and reference value for future researchers who will use artificial intelligence technology as the course content itself and promote the sustainable development of future artificial intelligence courses and socio-economic development.

2. Methods and Materials

2.1. Research Methods

In this study, we have used bibliometric methods, knowledge graph methods, and co-occurrence analyses. The methods used in the study of age distribution and journal

publication is a bibliometric analysis; the methods used in the research on the cooperative relationship between countries of publication, institutions of publication, and core authors are a co-occurrence analysis and knowledge graph method; the main research method used for keyword density and keyword time span analysis is the knowledge graph method, with a co-occurrence analysis as an auxiliary method. Among them, bibliometrics is a quantitative research method. Based on knowledge in the fields of mathematics, statistics, and other fields, data analysis can be performed on the documents studied, such as the number of documents, change rules, document titles, subject words, and co-citation times. Statistical analysis can be performed using bibliometrics [29–31]. A co-occurrence analysis is a method commonly used in literature metrology and content analysis, whose essence is to make pairwise statistics on the number of occurrences of a group of words in the same article and conduct a cluster analysis on these words so as to further analyze the internal research changes in the disciplines and topics represented by these words [32–34]. The knowledge atlas method is an interpretation that uses visual technology to describe knowledge resources and their carriers, repeatedly mining, analyzing, constructing, and displaying knowledge and their interrelationships. The knowledge atlas method is used to analyze the structure of literature knowledge and explore the hot research topics and research trends in the future [35,36].

The quantitative analysis software for knowledge atlas literature used in this study is VOSviewer version 1.6.19, which was developed by the Science and Technology Research Center of Leiden University in The Netherlands. It performs cluster knowledge atlas display, density knowledge atlas display, and overlay knowledge atlas display based on differences in key node spacing, density, and size, thereby analyzing and predicting current research directions, the hot research topics, and the future trends in the field of research [37,38]. In addition to VOSviewer-based visualization software, this study uses Origin software to conduct statistical and in-depth research on the co-authorship relationships of research documents, such as countries of publication, citation times, collaboration between the institutions of publication, and issuing journals in order to explore the development and research status of AI courses from a global perspective and to predict the trend of future AI course development.

2.2. Data Source

The data for this study is sourced from artificial intelligence course research literature collected in the WOS core database over the past decade and was retrieved on 4th January 2023. As a large-scale citation search database for international multidisciplinary professional journals, the Web of Science (hereinafter referred to as "WOS") has high academic value and influence [39,40]. The search topic keywords are "Artificial intelligence course" and "Artificial intelligence curriculum". The preliminary number of documents obtained is 1659, and conditions such as "document type" and "language" are also limited. Since this paper is written in 2023, the number of documents retrieved in 2023 does not represent the total number of documents in this year. Therefore, the author selects the search period from 2013 to 2022 and obtains 1402 documents in the past decade. Finally, the author obtains 1150 articles for research and analysis by reading the title and abstract, excluding articles that are not related to artificial intelligence, artificial intelligence courses, or artificial intelligence teaching, as well as those suspected of being published repeatedly. The process of selecting articles is shown in Figure 1. The content of the obtained document record is "full record and cited references" and the export format is "plain text file". Finally, we imported VOSviewer software to remove irrelevant keywords and display a visual map of literature knowledge.

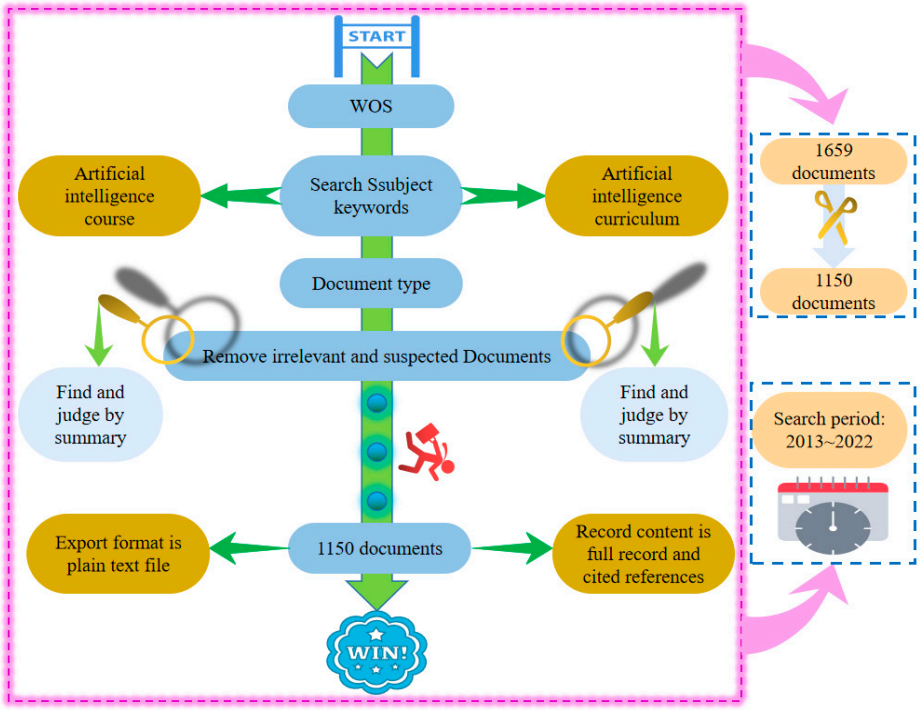

Figure 1. The article selection process for the bibliometric mapping analysis and systematic review.

2.3. Limitations of Research Data

We only analyzed the relevant achievements of artificial intelligence courses in the WOS database and have not included the relevant achievements included in other databases after analysis, which is a limitation of our research institute. It should be noted that we will use literature on the theme of "Artificial Intelligence Curriculum" as research samples to conduct a comprehensive study of the current research status and as inspiration for the sustainable development of artificial intelligence curriculum from a global perspective. The conclusions and results obtained can be extended to the entire education field, enabling educators and learners to learn to see the essence of phenomena and understand the principles of different advanced technologies. The impact of artificial intelligence on education is not just empowering it. Instead, it brings essential changes to education, such as thinking about how to teach artificial intelligence technology as a course content to students, cultivating their higher-order thinking abilities, and adapting to the constantly developing era of intelligence.

3. Development Status of Artificial Intelligence Courses

3.1. Age Distribution and Stage

This section uses bibliometric methods to calculate and analyze the annual publication volume of the literature on artificial intelligence courses. Statistics are made on the published years of the final selected articles, and the percentage of published articles per year in total is calculated. At the same time, the annual growth rate is calculated. The final result is shown in Figure 2.

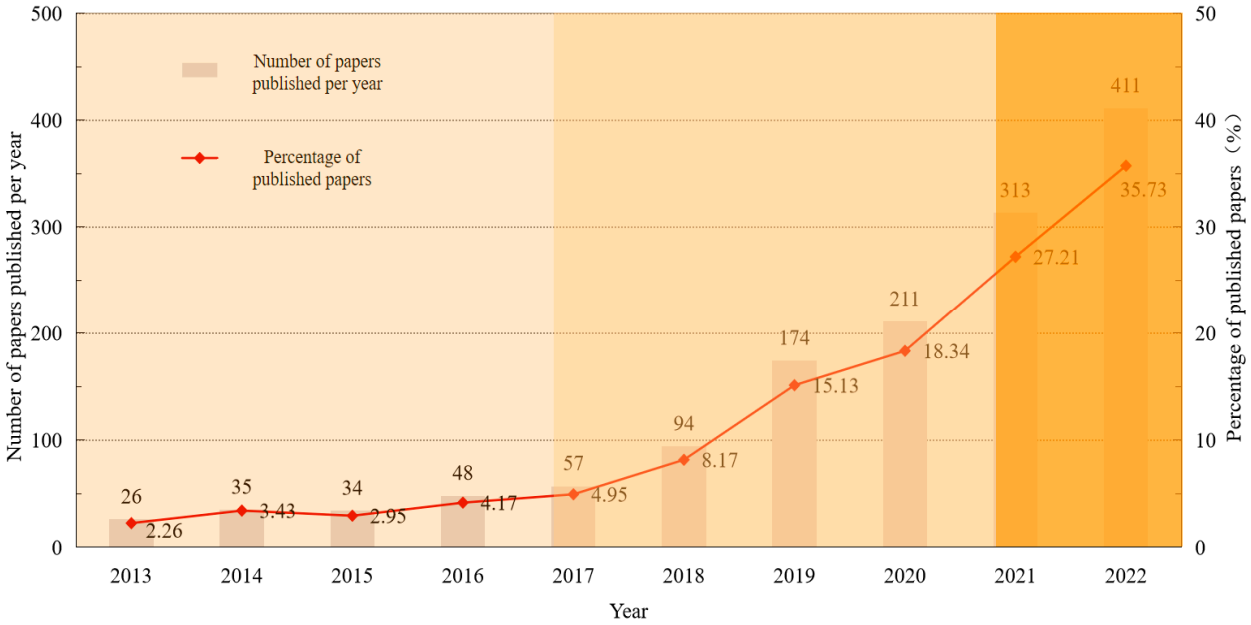

Figure 2. Number of papers issued for AI courses from 2013 to 2022.

In Figure 2, it can be seen that the number of papers related to the AI curriculum continues to increase with an increase in years. Therefore, the development process of the AI curriculum can be divided into three stages: slow development stage (2013~2016), rapid development stage (2017~2020), and mature development stage (2021~present).

In terms of research on the artificial intelligence curriculum, although the literature on artificial intelligence was also published every year before 2013, there was no substantive breakthrough, and artificial intelligence developed steadily. In 2012, the introduction of deep learning led to the breakthrough of artificial intelligence technology in the bottleneck period. The continuous deepening of the application of artificial intelligence technology in various industries and the triumph of Alpha Dog over the world Go champion had aroused the interest of scholars from various countries in artificial intelligence courses [41,42], and research related to artificial intelligence courses has, therefore, gradually begun. From 2013 to 2016, its research results showed a slow upward trend, but the research fields were relatively scattered and involved a wide range of types. The research on artificial intelligence courses at this stage was mainly manifested by a small number of scholars interested in artificial intelligence, mainly concentrated in higher education, and combined with popular majors such as computer, engineering education, and medicine to promote the development of different majors; they failed to form independent specialized research teams and knowledge systems.

The rapid development stage of artificial intelligence curriculum research is 2017–2020; and the reason for this cannot be separated from the policy support of various governments. For example, in 2017, the United Kingdom set up undergraduate courses in artificial intelligence at 26 universities as well as postgraduate courses in artificial intelligence [43]. France launched "Rapport de Synth è se France Intelligence Artificaelle", which aimed to vigorously develop the application and development of artificial intelligence in the field of education [44]. At this stage, AI curricula have been implemented in higher education, and some countries have involved AI courses in primary and secondary schools and have conducted research on the content of AI courses. In 2018, the Association for the Advancement of Artificial Intelligence (AAAI) and the Computer Science Teachers Association (CSTA) jointly initiated the establishment of the A14K12 Working Group to promote the implementation of artificial intelligence courses; they proposed five major concepts for the design of artificial intelligence curriculum education: perception, representation and reasoning,

machine learning, human–computer interaction, and social impact. Some scholars have conducted research on these five major concepts [45].

The mature development period of artificial intelligence curriculum research is from 2021 to now. During this period, the research results on artificial intelligence courses increased rapidly, with the annual volume of documents issued in 2021 and 2022 accounting for 27.21% and 35.73% of the total volume of documents issued in 2013–2022, respectively. In addition, during this period, the research on AI courses has also shifted from studying the promotion of AI technology to other majors studying the AI curriculum itself [46–48]. At the same time, there is ongoing research on the role of AI courses in promoting AI technology in higher education majors, and the number of research results on AI courses in the basic education stage has increased compared to the previous period. The content related to artificial intelligence has gradually entered people's vision, and primary and secondary schools around the world have also begun to attach importance to the implementation of artificial intelligence courses and take corresponding measures.

3.2. Countries of Publication

Artificial intelligence curricula have attracted attention in academic fields around the world, and the number of relevant academic achievements in various countries can, to some extent, reflect the research level in this field. Furthermore, cooperation between countries can reveal the research characteristics and technical strengths of countries in the field of artificial intelligence courses and can also reflect the overall research characteristics of this field. This section uses the knowledge graph method to display the countries of publication and the co-authorship relationships among them and uses a co-occurrence analysis to analyze the co-authorship relationships among the countries of publication. A total of 85 countries have conducted research on artificial intelligence courses based on the statistics of the countries to which 1150 authors belong. This study counts countries with five or more published papers and draws a national knowledge map of artificial intelligence course research, as shown in Figure 3.

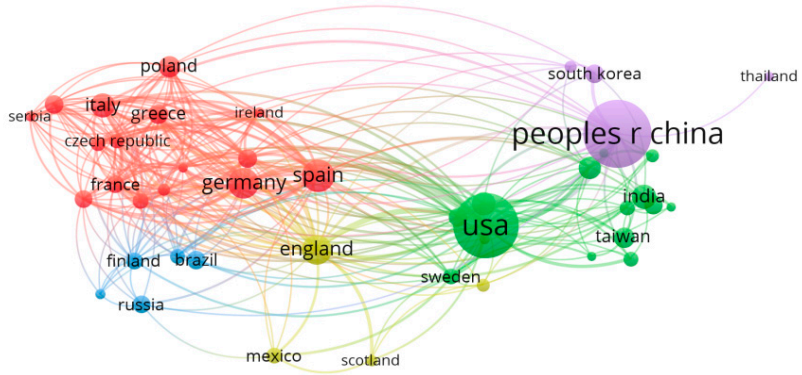

Figure 3. The countries of publication (national cooperative relationship).

In Figure 3, the larger the circle, the more documents issued by the country. The thicker the line between the two circles, the more cooperation times and the closer the cooperation relationship. It can be seen that the top countries in the total number of research papers issued for artificial intelligence curricula are China, the United States, Spain, Germany, and other countries, respectively, accounting for 21.82%, 19.73%, 5.13%, and 4.78% of the global total number. The cooperation between the United States, Germany, and other countries is more active. The cumulative number of papers from the top 50 countries accounts for 66.43% of the global total. From this, It can be concluded that a large part of the research results of artificial intelligence courses are produced by a few countries or regions, which are usually developed countries or individual developing countries. These countries or regions have been plagued by issues related to artificial intelligence courses in the process

of developing their own economies, and it can be concluded that artificial intelligence courses have emerged and developed with people's needs for artificial intelligence.

In addition, in order to more clearly grasp the global development context of AI curricula, this study further sorted out and visualized the evolution of the top nine countries with the highest number of publications in chronological order, and then analyzed the evolution process of the increase, decrease, and flattening of AI course research in these countries. In the presented evolution diagram, the higher the color block height, the more documents issued by the corresponding country. Different color blocks in the same year are sorted from top to bottom according to their height, as shown in Figure 4.

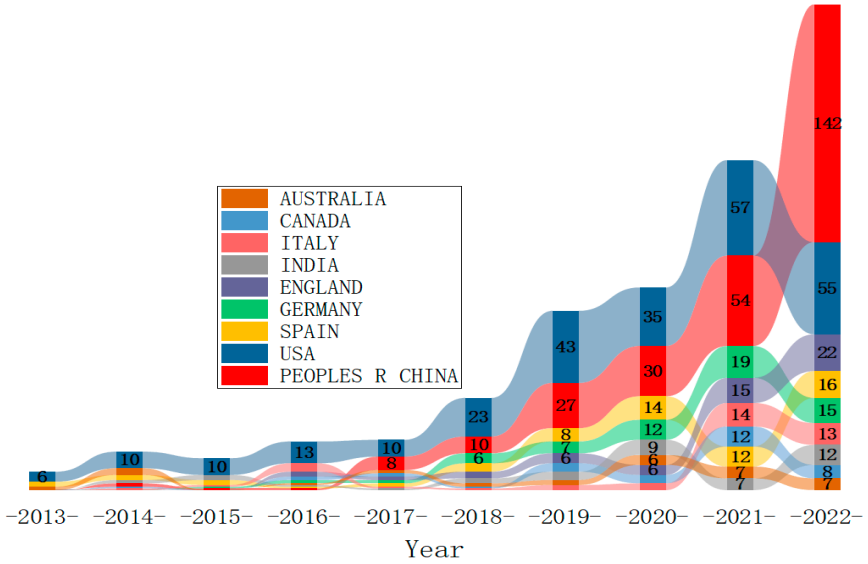

Figure 4. Evolution diagram of document volume in different countries.

As can be seen in Figure 4, the number of documents issued in artificial intelligence courses in China has steadily increased over time, especially in 2021 and 2022, where the number of documents issued for artificial intelligence courses in China has significantly increased, and in 2022, the number of documents issued in China ranked first in the world. The number of documents issued in artificial intelligence courses in the United States has also steadily increased over time but decreased slightly in 2022 (before 2022, the number of documents issued in artificial intelligence courses in the United States has always been first in the world). Among the other countries, Spain experienced a slight decline in the volume of documents issued for artificial intelligence courses in 2021, Canada in 2022, and Germany in 2022. Looking at the entire document volume evolution diagram, it can be seen that with the passage of time and the development of the national economy and technology, the document volume of AI-related courses has generally shown an upward trend (due to the relatively small document volume in many countries before 2020, the corresponding year's document volume is not shown in the diagram).

3.3. Institutions of Publication

In addition to analyzing the country of publication, this section uses the knowledge graph method to display the collaborative relationship graph among institutions of publication and uses the co-occurrence analysis method to analyze the collaborative relationship among institutions of publication. When obtaining the knowledge graph of different publishing institutions, the maximum threshold is set to 25 for each paper collaboration institution and the number of institutions with more than five publications. The results are shown in Figure 5.

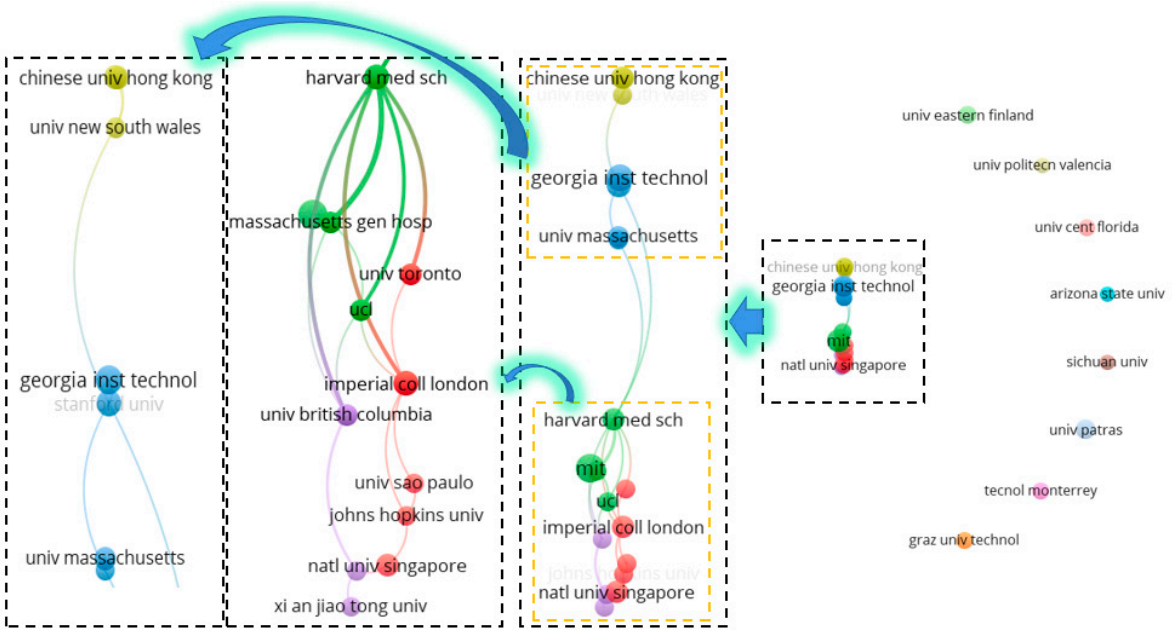

Figure 5. Knowledge map of organizations of publication.

As can be seen in Figure 5, most of the institutions publishing papers are related to universities, indicating that universities have a leading role in the research and development of artificial intelligence courses. The institutions with the highest number of published documents are mainly American and Chinese universities, such as the Massachusetts Institute of Technology (MIT), the Chinese University of Hong Kong, etc. Among them, MIT is a world-class private research university and a member of the Global University Presidents Forum. The Chinese University of Hong Kong is a public research-based comprehensive university, which is known as an academic hub in the fields of mathematics, computer science, media, and other fields. It is the only university in Hong Kong that simultaneously holds a Nobel Prize, Fields Prize, Turing Prize, and Shannon Prize winner. In addition, it can be seen that some universities, such as the University of Eastern Finland, the University Politecn Valencia, and the Graz University of Technology, have less cooperation with other universities, while the Chinese University of Hong Kong, Georgia Institute of Technology, Massachusetts Institute of Technology (MIT), National University of Singapore, and other universities have developed relatively close cooperative relationships, which can be mainly divided into two categories. In the first category, Stanford University is the center, and there are characteristics of cooperation with the Georgia Institute of Technology, the Chinese University of Hong Kong, and others. However, such cooperation presents a one-way distribution, which indicates that there is little cooperation among various national institutions on artificial intelligence curricula, and no cooperative group relationship has been formed. In the second category, University College London and Imperial College London have close cooperative relationships with more universities, while Xi'an Jiaotong University only has cooperative relationships with Nanyang Technological University.

The analysis of the above results shows that research related to AI curricula has been carried out in many universities and scientific research institutions, but the progress of research on AI varies in different countries; thus, research institutions in various countries have failed to form a mutually connected cooperative relationship. This also indicates that the research on artificial intelligence courses is still in the theoretical exploration stage and has not formed a truly cooperative system, which has not prompted many universities to form an organic cooperative community on artificial intelligence course research.

3.4. Journal of Publication

This section uses bibliometric methods to collect and analyze published journals on artificial intelligence courses. In addition, a river map is a very intuitive visual form that displays the evolution of data over time. It is used to display the annual publication volume of literature related to artificial intelligence courses in different journals. Of the 1150 articles analyzed in this study, 564 are articles, which were published in 270 journals. This study selects the journals with the highest published volume for analysis. River maps are a very intuitive visual form that show the evolution of data over time. This section obtains river maps for the number of publications of artificial intelligence courses published in different journal years, as shown in Figure 6.

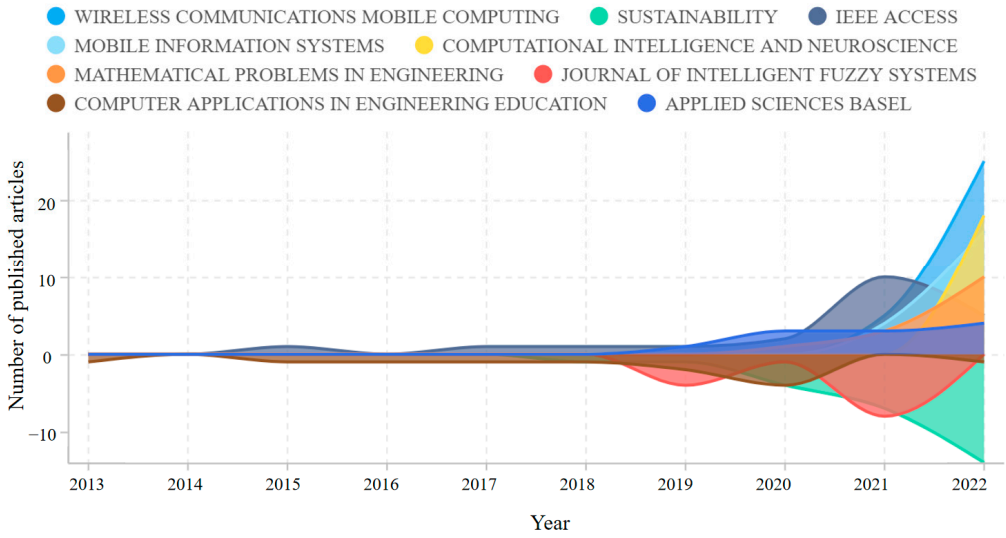

Figure 6. River chart of annual publication volume of different periodicals.

In Figure 6, the horizontal axis represents the time period 2013–2022 and the vertical axis represents the number of publications. The positive and negative values have the same meaning, and different color regions represent different journals. It can be seen that over time, the number of publications on AI curricula in different journals has been constantly changing, and the number of publications in most journals has shown an upward trend. The number of publications on AI courses in 2022 for the journals shown in Figure 6 is 93 times greater than 2013. In addition, AI course papers are distributed in journals in the fields of education, scientific disciplines, engineering, telecommunications, and other fields, indicating not only that AI courses involve knowledge in multiple different fields but also that they achieve and optimize AI in processing model construction, feature extraction, natural language processing, and other issues. More and more journals will pay more attention to the research of the artificial intelligence curriculum education.

Furthermore, the citation frequency of a paper can accurately reflect the quality of the paper and the degree of recognition by other researchers. This section analyzes the citation frequency of journals with relatively high publication volumes, and the results are shown in Figure 7.

As can be seen in Figure 7, both open-source and non-open-source journals have shown a gradual increase in the number of citations, especially in recent years, which indicates that more and more researchers are beginning to pay attention to the education of artificial intelligence courses. Among them, the total number of citations for the *Journal of Intelligent Fuzzy Systems* the non-open-source journal with the largest cumulative number of publications, is 106, and the total number of citations for *Wireless Communications and Mobile Computing*, the open-source journal with the largest cumulative number of publications, is 21. The papers from Bañeres in Universitat Obertade Catalunya and Chiu in the Chinese University of Hong Kong have a high number of citations, and the papers published by the

above scholars are also of great significance for the development of artificial intelligence curriculum research [49,50].

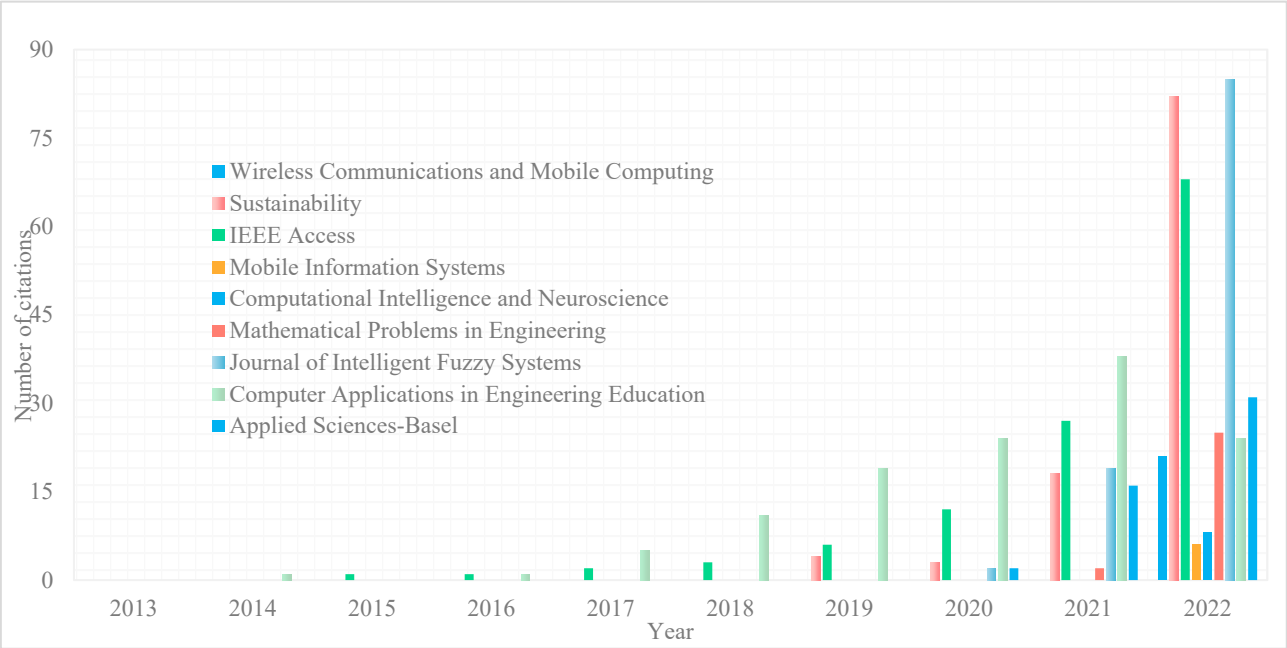

Figure 7. Changes in annual citation times of different periodicals.

3.5. Core Authors and Research Fields

The core author is an important power in promoting the development and innovation of artificial intelligence curricula, and they can form a leading discipline or academic research, forming an academic community with academic leaders as the core. This section uses the knowledge graph method to display core authors and the co-authorship relationship graph among them and uses a co-occurrence analysis to analyze the co-authorship relationship and collaborative research areas among core authors. There are a total of 4193 authors in 1150 documents, with Professor Cynthia Breazeal of the Massachusetts Institute of Technology posting the most articles, who has been selected by the Massachusetts Institute of Technology Technology Review as one of the 100 global innovators under the age of 35. According to Price's Law [51,52], the number of core author's papers is $m = 0.749 \times \sqrt{n_{max}} = 1.83$ (n_{max} = the number of papers by the most published authors). Therefore, in this study, authors with two or more published articles are identified as core authors, and 196 core authors are obtained, which accounts for 4.67% of all authors. Using VOSviewer to analyze 196 authors' collaborative networks, the core author network relationship map is shown in Figure 8.

In Figure 8, it can be seen that the researchers in the artificial intelligence curriculum are still in a decentralized state overall. There are 38 people who independently study artificial intelligence courses, forming ten-member academic cooperation groups and six-member collaborations, with two each. The number of nine-member cooperative groups, eight-member cooperative groups, and seven-member cooperative groups is all one. There are seven cooperative groups of five members and seven cooperative groups of three members each. There are four groups with four members working together. There are fifteen cooperative groups composed of two people. According to the above statistical results, the average number of collaborators per paper is 3.64.

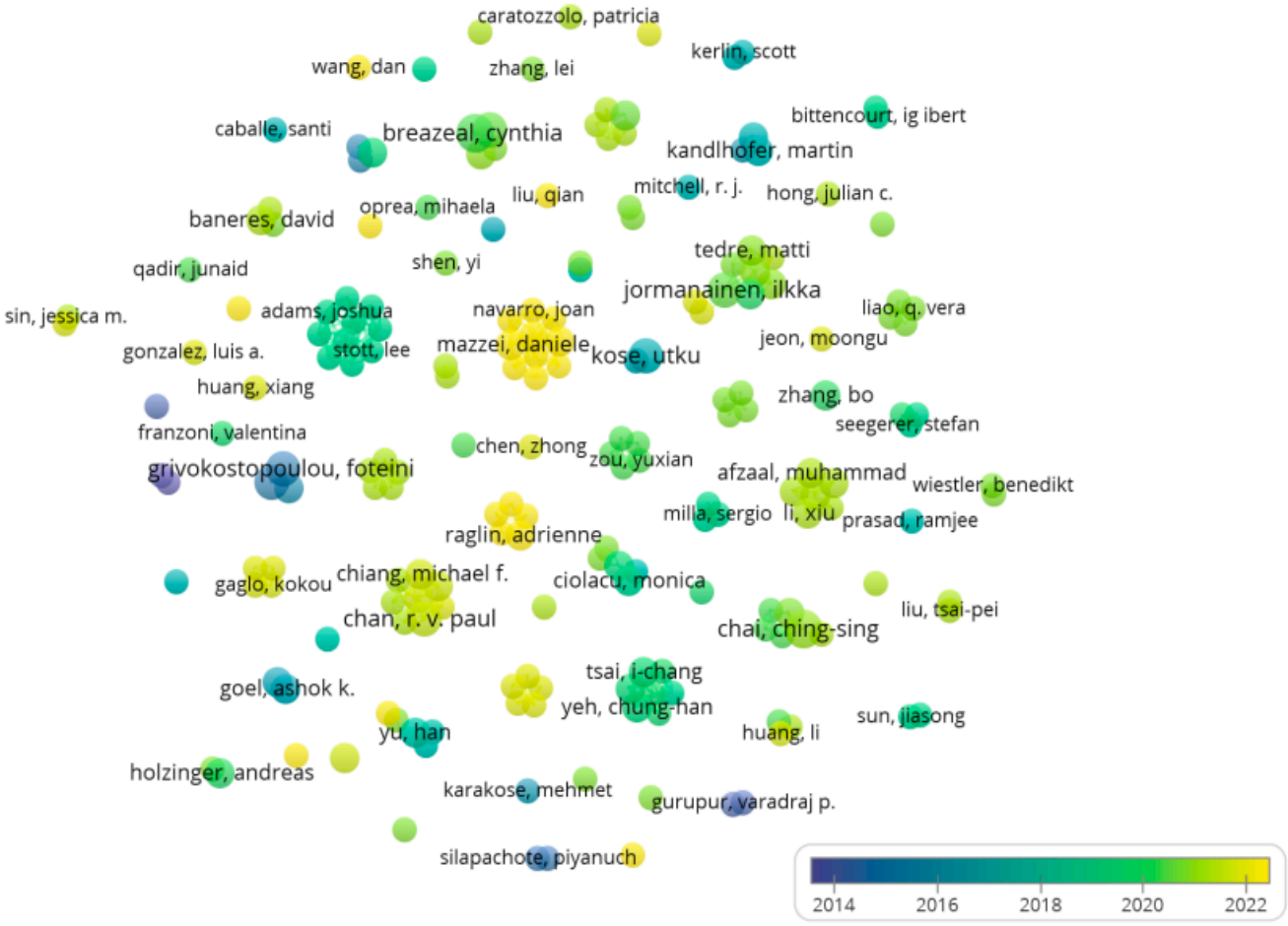

Figure 8. Core author collaboration association graph.

The number of scholars entering the research field of artificial intelligence courses continues to increase, and cooperation between scholars fluctuates greatly. With the continuous deepening of research, more and more scholars cooperate with each other. Foster, Adams, Stadnicka, and Jormanainen collaborate more in the field of artificial intelligence curriculum research and have a significant academic impact on academic output. Among them, Foster, Adams, and others conducted research for the academic community around 2018 on the development of cloud computing and cloud technology in computer science courses in the field of higher education [53]. In 2022, the cooperation community with Stadnicka as the core studied the importance of knowledge and skills in artificial intelligence (AI), the Internet of Things (loT), edge computing (EC), and other fields for college students, and proposed how to develop knowledge and skills in this field for students in universities [54,55]. In addition, Jormanainen, a nine-person academic group with a key node, is researching the integration of robotics into the artificial intelligence curriculum of K-12 education. At the same time, it focuses on how to teach machine learning concepts, cultivate information literacy, computational thinking, and other issues in the K-12 education curriculum, as well as developing teaching tools and teaching processes for issues arising from the teaching process curriculum [56,57].

4. The Hot Research Topics and Trends of the Artificial Intelligence Curriculum

The keyword is a summary of the research topic and content. By analyzing the keyword co-occurrence density map, the hot research topics in a certain field can be analyzed and summarized for future in-depth research [58–60]. By adding a time dimension and analyzing keyword co-occurrence across different time spans, it is possible to discover

changes in the scope of research topics and the evolution trajectory of the hot research topics in this field, thereby deriving future research trends in this field.

4.1. Keyword Co-Occurrence Density Map Analysis

This section uses the knowledge graph method to display keyword density and conducts a keyword co-occurrence analysis to identify current research hotspots in the field of artificial intelligence courses. This study analyzes 1150 documents and obtains a total of 3442 keywords. The minimum threshold for the number of keyword occurrences is set to five. There are 146 keywords that meet the conditions. A keyword co-occurrence density map is obtained through VOSviewer, as shown in Figure 9.

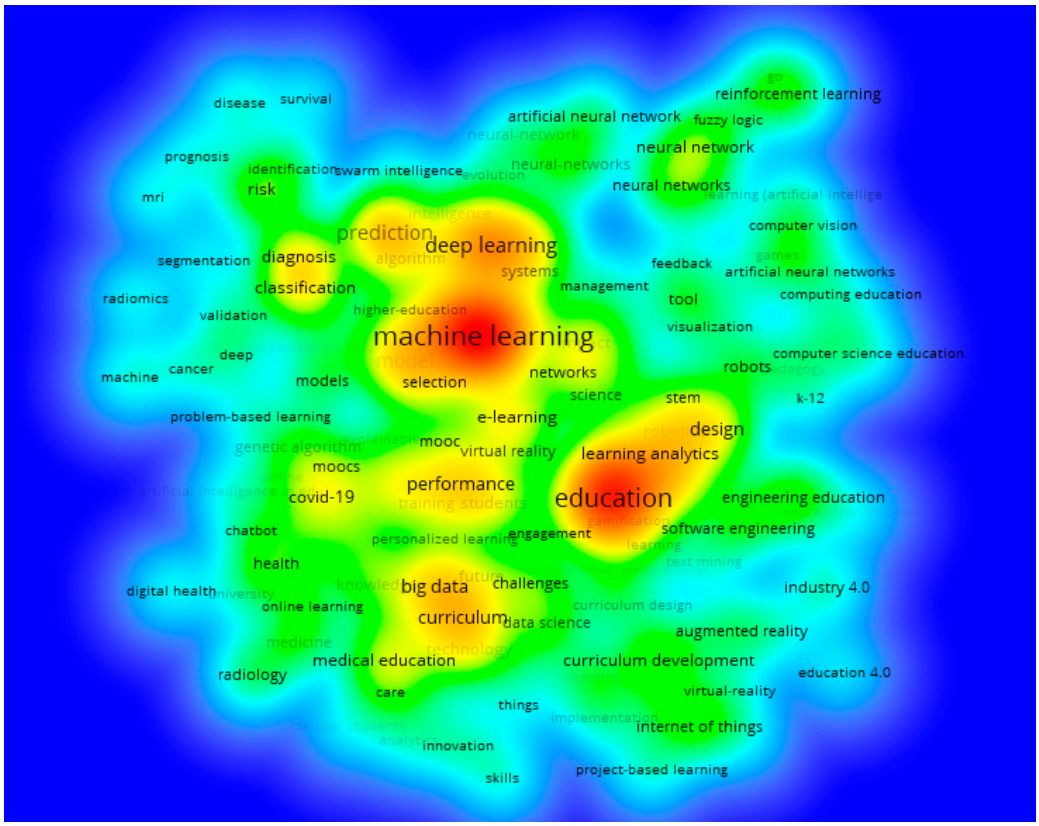

Figure 9. Keyword co-occurrence density diagram.

In Figure 9, each point has a color that represents the density of keywords at that point. The more keywords near a point, the higher the weight of adjacent keywords, and the closer the color of the point to red. Conversely, the smaller the number of keywords near a point, the lower the weight of adjacent items, and the closer the color of the point to blue. The keyword co-occurrence density map can reflect the important fields and the hot research topics of academic research in the artificial intelligence curriculum. As can be seen in Figure 9, the keyword co-occurrence density graph generally presents three gradient colors. The first gradient is located at the center, and the keywords in the red color are machine learning and education. Among them, the surrounding keywords are combined around artificial intelligence technology and education, both enabling education and serving as the content of education itself; the second gradient color is orange, and the keywords are deep learning, higher education, learning analysis, curriculum, and so on; the third gradient color is green, mainly combining artificial intelligence courses with computer related courses, including computer education, engineering education, software engineering, the Internet of Things, computing science education, and so on.

Through sorting out the research content, the author concludes that the current academic research focus on artificial intelligence courses can be divided into three themes.

First, artificial intelligence serves education as a technology that promotes more accurate, personalized, and intellectualized teaching outcomes. Student learning behavior data can be acquired and analyzed through intelligent technologies such as big data technology, machine learning technology, deep learning technology, and learning analysis technology. The behavior of students can be studied in the process of learning and mastering course knowledge through neural network algorithms, optimization algorithms, and prediction techniques, which can predict their learning behavior and academic performance and achieve more digital and intelligent teaching. The second is the two education directions of artificial intelligence courses at different education stages. The second theme is the two education directions of artificial intelligence courses at different education stages. (1) In higher education, AI curricula are mainly taught in some special fields such as engineering education, engineering education, computer education, and medical education, such as data mining, group intelligence, modeling, artificial intelligence, neural networks, and reinforcement learning, to develop professionals in various fields who can meet the needs of social development faster. (2) In K-12 basic education, intelligent robots are used to assist in the cultivation of students' core academic literacy. More importantly, they use interdisciplinary forms and STEM education to teach artificial intelligence courses to cultivate students' computational thinking, digital literacy, and information literacy, thereby developing their comprehensive quality and ability and mastering comprehensive skills to adapt to the development of the intelligent era. The third theme is the teaching forms in the field of artificial intelligence courses, such as project-based teaching, problem-oriented teaching, collaborative learning, online learning, hybrid learning, and so on. Exploring the teaching modes of artificial intelligence courses can meet the learning needs of students to facilitate the cultivation of high-quality talents in the 21st century.

At the same time, it is worth noting that the color of the region where machine learning is located is closer to red than deep learning, which indicates that in-depth research on machine learning is currently an important field in the hot research topic of artificial intelligence courses. Additionally, it is explained that although deep learning attempts to directly obtain high-level features from data, it has advantages such as strong generalization ability. On the one hand, compared to deep learning, this may be because machine learning, such as decision trees, can provide us with clear rules and is more likely to interpret the reasoning behind algorithms, which helps the teaching of artificial intelligence course educators. On the other hand, compared to deep learning, machine learning is more universal in application and knowledge content understanding, making it easier for students to learn and master. Therefore, in the K-12 basic education stage, machine learning is regarded as one of the five major concepts, and the content of artificial intelligence curriculum education is carried out.

4.2. Keyword Co-Occurrence Time Span Analysis

This section uses the knowledge graph method to display keyword knowledge graphs under different time spans, uses a co-occurrence analysis to analyze future research trends in the field of artificial intelligence courses, and adds the time dimension to the analysis of keywords to further analyze the research trends of artificial intelligence courses. Different colors represent the average year of occurrence of each keyword, and the closer the color is closer to red, the later the keyword appears. The closer the color is to blue, the earlier the keyword appears, as shown in Figure 10.

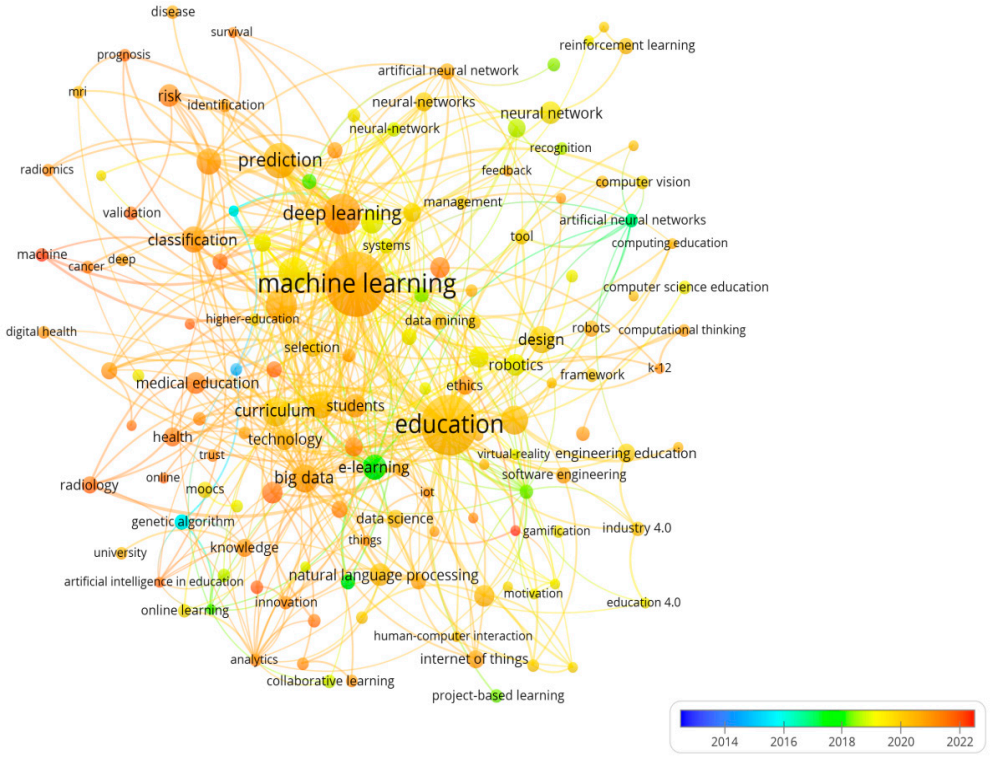

Figure 10. Keyword visualization knowledge map.

In Figure 10, the size of the circle where the keyword is located represents the frequency of the keyword occurrence. The more frequent the occurrence, the larger the circle. The line between the circles represents a co-occurrence relationship between the two keywords, and the line width represents the frequency at which the two keywords occur together. The more frequent the co-occurrence, the wider the line. It can be seen that among all the keyword co-occurrences, machine learning and education appear the most frequently. According to statistics, the number of occurrences of machine learning is 108, and the total connection strength with other keywords is 258. Moreover, the number of times machine learning and other keywords appear together in the same document or multiple documents is 98. The number of times education appears is 95, with a total connection strength of 222 times with other keywords, and the number of times it appears in the same document or multiple documents together with other keywords is 118 times. Therefore, research on machine learning is the top priority in the field of artificial intelligence curriculum research. This section analyzes the research trends of the AI curriculum from three perspectives: how to better implement AI-related knowledge in the form of courses, which parts of AI should be implemented for different teaching objects, and which groups should teach AI courses.

Firstly, from the visual knowledge map of keywords, it can be seen that e-learning, project-based learning, collaborative learning, and human–computer interaction keyword clusters are green and orange, indicating that the current teaching form of artificial intelligence courses is a trend in future research. E-learning provides learners with a new way of learning, enhancing the feasibility of learning anytime and anywhere, and provides the possibility of lifelong learning. In the context of the AI curriculum, it can be seen that e-learning emerged relatively early, showing the early rise of research on how to carry out AI courses through different educational methods from a global perspective. However, e-learning cannot completely replace face-to-face learning, and it is necessary to use blended learning to carry out artificial intelligence course teaching. Project-based learning was applied in the teaching of artificial intelligence courses as early as 2018. As research continues to deepen, the teaching forms and content of project-based teaching continue to be enriched, and interdisciplinary project-based teaching methods and forms continue to be used in project-based teaching

activities, which helps students participate in real-life and use their knowledge to solve practical problems [61]. Collaborative learning is a rising form of teaching, and a large number of studies have demonstrated the applicability of collaborative learning in teaching implementation from theories and methods [62]. Human–computer interaction (HCI) is an artificial intelligence technology, and its flexible application in teaching activities is also a hot research topic in the teaching of artificial intelligence courses to promote the teaching of the artificial intelligence curriculum itself [63]. In addition to using artificial intelligence, teaching in artificial intelligence courses is based on different environments, as well as forming an "artificial intelligence + environment" curriculum teaching mode to help the educated get out of their comfort zone and have sufficient opportunities to practice technical and non-technical skills so as to maximize the learning ability of the educated. At the same time, it aims to link the problems of different environments with artificial intelligence courses to improve the knowledge acquisition, reflection, and practical abilities of the educated.

Secondly, the content taught and skills developed for AI courses vary from education stage to education stage. As can be seen in the keyword knowledge map in Figure 10, both higher education and K-12 education have been the focus of attention in relevant fields of artificial intelligence courses since 2019. The total connection strength between higher education and other keywords link is 64. The content of artificial intelligence courses mainly involves professional terms and technical principles in the field of artificial intelligence technology, such as prediction, optimization, algorithm, explainable AI, and learning analytics. For example, data science is an emerging professional field in higher education, which mainly trains data science professionals. What it needs is experts with knowledge in statistics, computer science, artificial intelligence, and machine learning [64]. Moreover, at the stage of higher education, various countries are undergoing reforms in engineering education, such as Germany's "Industry 4.0", the United States' "Industrial Internet Strategy", France's "New Industry France", Japan's "Japan Revitalization Strategy", and China's "Made in China 2025". A series of strategic deployments have made arrangements for the development of engineering education. Effective validation can be obtained from the keyword visualization knowledge map, with the number of occurrences of engineering education being 15, and the total connection strength between engineering education and other keywords being 19. In addition, the number of occurrences of medical education is 25, and the total connection strength between medical education and other keywords is 39. On the one hand, it can be seen that medical education appeared later than engineering education. In the engineering field, researchers recognized the powerful feature extraction performance of artificial intelligence earlier and successively carried out education on artificial intelligence courses for relevant practitioners in the engineering field. On the other hand, it can be seen that, at present, the application of artificial intelligence in the medical field has become an important direction for the development of intelligent medicine. However, due to the interdisciplinary expertise of artificial intelligence involving computer science and mathematics, it is difficult for a large number of doctors to master the technology of artificial intelligence and apply it to scientific research and work. Therefore, how to better teach artificial intelligence to medical practitioners is a current research and future research trend. In the keyword knowledge map, the total connection strength between the "K-12" keyword and other keywords is 24, and the displayed color is orange, approaching red, which indicates that the development of K-12 artificial intelligence courses at the basic education stage is one of the current and future hot topics of academic research. Other keywords that appear together with the "K-12" keyword include machine learning, computer education, computational thinking, classification, ethics, and robotics, which appeared as early as 2018. The combination of these keywords indicates that in the K-12 education stage, the content of artificial intelligence courses is more about cultivating primary and secondary school students' interest, information awareness, and computational thinking about artificial intelligence technology in the intelligence era through computer education and basic machine learning knowledge while paying attention to the understanding of

social and ethical issues of artificial intelligence in primary and secondary schools so as to cultivate students' core academic literacy in artificial intelligence [65,66].

Finally, artificial intelligence technology is widely used in various fields, and its teaching objects are not only students, but also teachers, medical workers, and enterprise workers. The content of the artificial intelligence course mainly includes the impact of artificial intelligence technology in human society, artificial intelligence and human intelligence, and artificial intelligence technology and its principles. It is necessary to carry out artificial intelligence education in the form of courses. Due to the fact that AI technology covers multiple fields and disciplines such as mathematics, computer science, and neuroscience, it needs to develop different curriculum standards to teach different concepts and technical principles and cultivate corresponding information technology capabilities of AI in different environments, different objects, and different learning goals and objectives. Therefore, at present, artificial intelligence courses are more local courses than school-based courses. Many scholars have conducted research on the above issues, which can, on the one hand, enable teaching subjects to have a clearer plan of the content and methods of artificial intelligence courses, and on the other hand, enable learners to clearly understand the corresponding content. It should be noted that the AI course is not a purely technical course. The focus of the course is not to teach learners how to use programming tools, but rather to enable them to learn to see the essence of phenomena, understand the principles behind AI, and better understand the dual impact of AI on society and life. At present, the research preface to the content of the artificial intelligence course emphasizes that everyone should have the artificial intelligence literacy to adapt to more efficient and scientific human–computer collaboration capabilities in the future, rather than just mastering artificial intelligence-related technologies.

5. Conclusions

The sustainable and high-quality development of artificial intelligence courses is of great significance for the widespread application of artificial intelligence in various industries in society. However, the specific curriculum standards and plans for artificial intelligence courses in various stages are still being explored, and the specific implementation of artificial intelligence courses varies from country to region. This article provides an in-depth analysis of the current research status of artificial intelligence courses by scholars from various countries and fields from a global perspective. It demonstrates three periods of research and development of artificial intelligence courses in the past decade, identifies the main countries, institutions, and published journals related to the development of artificial intelligence courses, and summarizes the current hotspots and future research trends of artificial intelligence course research.

This study opens up a new perspective for the field of artificial intelligence course research, using relevant literature on artificial intelligence course research from the past decade included in the WOS core database as the research content. It studies how to better teach artificial intelligence technology to students, provides reference value for the efficient and sustainable development of future society, and points out the direction for the efficient and sustainable development of future artificial intelligence courses. In terms of theoretical impact, in the era of artificial intelligence technology empowering education, it is not only necessary to pay attention to the impact of artificial intelligence technology on education but also consider the changes that artificial intelligence technology brings to the essence of education, namely changes in educational content, talent training objectives, training methods, educational evaluation methods, and even educational models. In terms of the practical impact, firstly, it can help educators form a curriculum teaching model based on "artificial intelligence + environment", enabling them to step out of their comfort zone, maximize their teaching ability, and enhance their learning ability. Secondly, educators, researchers, and even educational managers need to consider the characteristics of the field when teaching artificial intelligence courses in different subject areas and teach the content of artificial intelligence courses based on the characteristics of the field. Finally, it is

necessary to explain the educational essence behind the teaching phenomenon of AI course content, that is, the focus of AI courses is not to teach learners how to use programming tools, but to let learners learn to see the essence of things from the phenomenon, understand the rationale behind AI technology, and understand the double-sided impact of AI on society and life. At the same time, learning intelligent technology as much as possible enhances one's higher-order thinking ability, combines intelligent technology with one's own learning and work so as to solve some complex and low-quality structural problems in life, and promotes a better life.

This study believes that the purpose of empowering education with artificial intelligence technology is to promote the sustainable development of education and cultivate high-quality talents who can adapt to the development of the intelligence era. Therefore, when applying artificial intelligence technology to educational and teaching activities, as well as teaching artificial intelligence technology as the course content itself, consideration should be given to learners' learning needs, previous learning experiences, and their "nearest development zone". The use of artificial intelligence technology should better meet learners' needs, stimulate learners' interests, and promote personalized and diversified development of learners, which requires educators and researchers to fully utilize intelligent technology, explore new teaching models, and use teaching models where students develop intelligent thinking, rather than an educational atmosphere where technology follows the trend and prioritizes technology. At the same time, the changes in the nature of education that have been brought about by AI technology in combination with educational psychology, pedagogy, and even biological knowledge, and students' high-level thinking and high-level ability, rather than the ability to use programming tools, should be explored and thought about when teaching the content of AI courses.

This study analyzed only the relevant achievements of artificial intelligence courses in the WOS database and has not included the relevant achievements included in other databases after analysis. This is the limitation of this study. In future research, the authors will consider incorporating the relevant results of artificial intelligence courses from more databases into the analysis in order to comprehensively analyze the current situation and implications of sustainable development of artificial intelligence courses from a global perspective.

Author Contributions: Conceptualization, Y.Y.; methodology, Y.Y. and J.Q.; software, Y.Y., J.Q. and J.L.; data curation, Y.Y. and J.L.; writing—original draft preparation, Y.Y.; writing—review and editing, Y.Y., J.Q. and Y.L.; visualization, Y.Y. and J.L.; supervision, Y.Y. All authors have read and agreed to the published version of the manuscript.

Funding: This study was supported by the General Special Scientific Research Plan of the Shaanxi Provincial Department of Education (grant No. 20JK0754).

Institutional Review Board Statement: Not applicable.

Informed Consent Statement: Not applicable.

Data Availability Statement: Not applicable.

Acknowledgments: The authors thank the editor for editing assistance. Lastly, the authors would like to thank the reviewers for their valuable comments and suggestions on an earlier version of our manuscript.

Conflicts of Interest: The authors declare no conflict of interest.

References

1. Acosta, J.N.; Falcone, G.J.; Rajpurkar, P.; Topol, E.J. Multimodal Biomedical AI. *Nat. Med.* **2022**, *28*, 1773–1784. [CrossRef] [PubMed]
2. Krishnankutty, R.; Bharti, T.; Mishra, N. Herding behaviour and capital structure decision in BSE listed Indian firms. *Int. J. Manag. Financ. Account.* **2022**, *14*, 118–137. [CrossRef]
3. Tiwari, A.K.; Abakah, E.J.A.; Gil-Alana, L.A.; Abakah, M.K. Inflation Co-Movement Dynamics: A Cross-Country Investigation Using a Continuous Wavelet Approach. *J. Risk Financ. Manag.* **2021**, *14*, 613. [CrossRef]

4. Bharti, T.; Ojha, S.C.; Tiwari, A.K. Interplay of Workplace Sustainability, Sustainable Work Performance, Optimism, and Resilience: The Moderating Role of Green Creativity in Luxury Hotels. *Sustainability* **2022**, *14*, 15097. [CrossRef]
5. Huang, X.; Qiao, C. Enhancing Computational Thinking Skills Through Artificial Intelligence Education at a STEAM High School. *Sci. Educ.* **2022**, 1–21. [CrossRef]
6. Zingoni, A.; Taborri, J.; Panetti, V.; Bonechi, S.; Aparicio-Martínez, P.; Pinzi, S.; Calabrò, G. Investigating Issues and Needs of Dyslexic Students at University: Proof of Concept of an Artificial Intelligence and Virtual Reality-Based Supporting Platform and Preliminary Results. *Appl. Sci.* **2021**, *11*, 4624. [CrossRef]
7. Cellina, M.; Cè, M.; Irmici, G.; Ascenti, V.; Caloro, E.; Bianchi, L.; Pellegrino, G.; D'Amico, N.; Papa, S.; Carrafiello, G. Artificial Intelligence in Emergency Radiology: Where Are We Going? *Diagnostics* **2022**, *12*, 3223. [CrossRef] [PubMed]
8. Nor, A.K.M.; Pedapati, S.R.; Muhammad, M.; Leiva, V. Overview of Explainable Artificial Intelligence for Prognostic and Health Management of Industrial Assets Based on Preferred Reporting Items for Systematic Reviews and Meta-Analyses. *Sensors* **2021**, *21*, 8020. [CrossRef]
9. Ilkka, T. *The Impact of Artificial Intelligence on Learning, Teaching, and Education*; EU: Luxembourg, 2018.
10. OECD. Trustworthy Artificial Intelligence (AI) in Education: Promises and Challenges. Available online: https://www.oecd-ilibrary.org/education/trustworthy-artificial-intelligence-ai-in-education_a6c90fa9-en (accessed on 22 December 2022).
11. El-Meniawy, N.; Rizk, M.R.M.; Ahmed, M.A.; Saleh, M. An Authentication Protocol for the Medical Internet of Things. *Symmetry* **2022**, *14*, 1483. [CrossRef]
12. Kumar, M.G.V.; Čepová, L.; Raja, M.A.M.; Balaram, A.; Elangovan, M. Evaluation of the Quality of Practical Teaching of Agricultural Higher Vocational Courses Based on BP Neural Network. *Appl. Sci.* **2023**, *13*, 1180. [CrossRef]
13. Albulescu, C.T.; Tiwari, A.K.; Kyophilavong, P. Nonlinearities and Chaos: A New Analysis of CEE Stock Markets. *Mathematics* **2021**, *9*, 707. [CrossRef]
14. Huang, X. Aims for cultivating students' key competencies based on artificial intelligence education in China. *Educ. Inf. Technol.* **2021**, *26*, 5127–5147. [CrossRef]
15. Heredia-Negron, F.; Alamo-Rodriguez, N.; Oyola-Velazquez, L.; Nieves, B.; Carrasquillo, K.; Hochheiser, H.; Fristensky, B.; Daluz-Santana, I.; Fernandez-Repollet, E.; Roche-Lima, A. Evaluation of AIML + HDR—A Course to Enhance Data Science Workforce Capacity for Hispanic Biomedical Researchers. *Int. J. Environ. Res. Public Health* **2023**, *20*, 2726. [CrossRef] [PubMed]
16. UNESCO. K-12 AI Curricula: A Mapping of Government-Endorsed AI Curricula. Available online: https://unesdoc.unesco.org/ark:/48223/pf0000380602 (accessed on 22 December 2022).
17. Fernández, C.; Vicente, M.A.; Martínez-Rach, M.O. Implementation of a face recognition system as experimental practices in an artificial intelligence and pattern recognition course. *Comput. Appl. Eng. Educ.* **2020**, *28*, 497–511. [CrossRef]
18. Farahmand, F. Integrating cybersecurity and artificial intelligence research in engineering and computer science education. *IEEE Secur. Priv.* **2021**, *19*, 104–110. [CrossRef]
19. Liang, X.; Lv, H.; Liu, J.; Lin, L. Reform of English interactive teaching mode based on cloud computing artificial intelligence–a practice analysis. *J. Intell. Fuzzy Syst.* **2021**, *40*, 3617–3629. [CrossRef]
20. Udupa, P. Application of artificial intelligence for university information system. *Appl. Artif. Intell.* **2022**, *114*, 105038. [CrossRef]
21. Barriga, N.A.; Besoain, F. Artificial intelligence and mobile programming courses for a video game development program in Chile. *Comput. Sci. Eng.* **2020**, *22*, 17–25. [CrossRef]
22. Laupichler, M.C.; Hadizadeh, D.R.; Wintergerst, M.W.; Von der Emde, L.; Paech, D.; Dick, E.A.; Raupach, T. Effect of a flipped classroom course to foster medical students' AI literacy with a focus on medical imaging: A single group pre-and post-test study. *BMC Med. Educ.* **2022**, *22*, 803. [CrossRef]
23. Salas-Pilco, S.Z.; Xiao, K.; Oshima, J. Artificial Intelligence and New Technologies in Inclusive Education for Minority Students: A Systematic Review. *Sustainability* **2022**, *14*, 13572. [CrossRef]
24. Hwang, G.-J.; Tu, Y.-F. Roles and Research Trends of Artificial Intelligence in Mathematics Education: A Bibliometric Mapping Analysis and Systematic Review. *Mathematics* **2021**, *9*, 584. [CrossRef]
25. Jobin, A.; Ienca, M.; Vayena, E. The global landscape of AI ethics guidelines. *Nat. Mach. Intell.* **2019**, *1*, 389–399. [CrossRef]
26. Xing, Z.; Zhao, S.; Guo, W.; Guo, X.; Wang, S.; Li, M.; Wang, Y.; He, H. Analyzing point cloud of coal mining process in much dust environment based on dynamic graph convolution neural network. *Environ. Sci. Pollut. Res.* **2023**, *30*, 4044. [CrossRef]
27. Hamamoto, R.; Suvarna, K.; Yamada, M.; Kobayashi, K.; Shinkai, N.; Miyake, M.; Takahashi, M.; Jinnai, S.; Shimoyama, R.; Sakai, A.; et al. Application of Artificial Intelligence Technology in Oncology: Towards the Establishment of Precision Medicine. *Cancers* **2020**, *12*, 3532. [CrossRef]
28. Xing, Z.; Zhao, S.; Guo, W.; Guo, X.; Wang, Y.; Bai, Y.; Zhu, S.; He, H. Identifying Balls Feature in a Large-Scale Laser Point Cloud of a Coal Mining Environment by a Multiscale Dynamic Graph Convolution Neural Network. *ACS Omega* **2022**, *7*, 4892. [CrossRef] [PubMed]
29. Ngwenya, S.; Boshoff, N. Different manifestations of 'context': Examples from a bibliometric study of research in Zimbabwe in Southern Africa. *Scientometrics* **2022**, *127*, 3911–3933. [CrossRef]
30. Liu, Z.; Yang, Z.; Xiao, C.; Zhang, K.; Osmani, M. An Investigation into Art Therapy Aided Health and Well-Being Research: A 75-Year Bibliometric Analysis. *Int. J. Environ. Res. Public Health* **2022**, *19*, 232. [CrossRef] [PubMed]
31. Arsad, A.Z.; Sebastian, G.; Hannan, M.A.; Ker, P.J.; Rahman, M.S.A.; Mansor, M.; Lipu, M.S.H. Solid State Switching Control Methods: A Bibliometric Analysis for Future Directions. *Electronics* **2021**, *10*, 1944. [CrossRef]

32. Memon, A.; Kilby, J.; Breñosa, J.; Espinosa, J.C.M.; Ashraf, I. Analysis and Implementation of Human Mobility Behavior Using Similarity Analysis Based on Co-Occurrence Matrix. *Sensors* **2022**, *22*, 9898. [CrossRef]
33. Chen, S.; Chen, Y.; Yuan, F.; Chang, X. Establishment of herbal prescription vector space model based on word co-occurrence. *J. Supercomput.* **2020**, *76*, 3590–3601. [CrossRef]
34. Gorzeń-Mitka, I.; Bilska, B.; Tomaszewska, M.; Kołożyn-Krajewska, D. Mapping the Structure of Food Waste Management Research: A Co-Keyword Analysis. *Int. J. Environ. Res. Public Health* **2020**, *17*, 4798. [CrossRef] [PubMed]
35. Del Mondo, G.; Peng, P.; Gensel, J.; Claramunt, C.; Lu, F. Leveraging Spatio-Temporal Graphs and Knowledge Graphs: Perspectives in the Field of Maritime Transportation. *ISPRS Int. J. Geo-Inf.* **2021**, *10*, 541. [CrossRef]
36. Lin, J.; Zhao, Y.; Huang, W.; Liu, C.; Pu, H. Domain knowledge graph-based research progress of knowledge representation. *Neural Comput. Appl.* **2021**, *33*, 681–690. [CrossRef]
37. Sun, X.; Li, T.; Wang, P.; Shang, L.; Niu, M.; Meng, X.; Shao, H. Nanomaterials and Advances in Tumor Immune-Related Therapy: A Bibliometric Analysis. *J. Biomed. Nanotechnol.* **2022**, *18*, 2154–2170. [CrossRef]
38. Kuzior, A.; Sira, M. A Bibliometric Analysis of Blockchain Technology Research Using VOSviewer. *Sustainability* **2022**, *14*, 8206. [CrossRef]
39. Ribeiro, A.P.D.; Almeida, R.F.; Medonca, J.G.A.; Leal, S.C. Oral health and its effect on the academic performance of children and adolescents. *Pediatr. Dent.* **2018**, *40*, 12–17. [PubMed]
40. Barbosa, A.; Whiting, S.; Simmonds, P.; Scotini Moreno, R.; Mendes, R.; Breda, J. Physical Activity and Academic Achievement: An Umbrella Review. *Int. J. Environ. Res. Public Health* **2020**, *17*, 5972. [CrossRef]
41. LeCun, Y.; Bengio, Y.; Hinton, G. Deep learning. *Nature* **2015**, *521*, 436–444. [CrossRef]
42. Véstias, M.P.; Duarte, R.P.; de Sousa, J.T.; Neto, H.C. Moving Deep Learning to the Edge. *Algorithms* **2020**, *13*, 125. [CrossRef]
43. Wood, R. Artificial Intelligence a Collaboration. Available online: https://www.gov.uk/government/speeches/artificial-intelligence-a-collaboration (accessed on 6 January 2023).
44. Gouvernement Français. Rapport de Synthèse France Intelligence Artificielle. Available online: https://www.economie.gouv.fr/files/files/PDF/2017/Rapport_synthese_France_IA_.pdf (accessed on 8 January 2023).
45. Touretzky, D.; Gardner-McCune, C.; Martin, F.; Seehorn, D. Envisioning AI for K-12: What should every child know about AI? In Proceedings of the 2019 Proceedings of the AAAI Conference on Artificial Intelligence, Honolulu, HI, USA, 27 January–1 February 2019; pp. 9795–9799.
46. Hedderich, D.M.; Keicher, M.; Wiestler, B.; Gruber, M.J.; Burwinkel, H.; Hinterwimmer, F.; Czempiel, T.; Spiro, J.E.; Pinto dos Santos, D.; Heim, D.; et al. AI for Doctors—A Course to Educate Medical Professionals in Artificial Intelligence for Medical Imaging. *Healthcare* **2021**, *9*, 1278. [CrossRef]
47. Pantelimon, F.-V.; Bologa, R.; Toma, A.; Posedaru, B.-S. The Evolution of AI-Driven Educational Systems during the COVID-19 Pandemic. *Sustainability* **2021**, *13*, 13501. [CrossRef]
48. Dai, Y.; Chai, C.-S.; Lin, P.-Y.; Jong, M.S.-Y.; Guo, Y.; Qin, J. Promoting Students' Well-Being by Developing Their Readiness for the Artificial Intelligence Age. *Sustainability* **2020**, *12*, 6597. [CrossRef]
49. Bañeres, D.; Rodríguez, M.E.; Guerrero-Roldán, A.E.; Karadeniz, A. An Early Warning System to Detect At-Risk Students in Online Higher Education. *Appl. Sci.* **2020**, *10*, 4427. [CrossRef]
50. Chiu, T.K.F.; Chai, C.-S. Sustainable Curriculum Planning for Artificial Intelligence Education: A Self-Determination Theory Perspective. *Sustainability* **2020**, *12*, 5568. [CrossRef]
51. Povedano-Montero, F.J.; Weinreb, R.N.; Raga-Martínez, I.; Romero, A.; López-Muñoz, F. Detection of Neurological and Ophthalmological Pathologies with Optical Coherence Tomography Using Retinal Thickness Measurements: A Bibliometric Study. *Appl. Sci.* **2020**, *10*, 5477. [CrossRef]
52. Gams, M.; Kolenik, T. Relations between Electronics, Artificial Intelligence and Information Society through Information Society Rules. *Electronics* **2021**, *10*, 514. [CrossRef]
53. Erdil, D.C.; White, L.; Foster, D.; Adams, J.; Cruz, A.J.A.; Hainey, B.; Hyman, H.; Lewis, G.; Nazir, S.; Nguyen, M.V.; et al. Toward developing a cloud computing model curriculum. In Proceedings of the 2019 ACM Conference on Innovation and Technology in Computer Science Education, Scotland, UK, 15–17 July 2019; pp. 255–256.
54. Dec, G.; Stadnicka, D.; Paśko, Ł.; Mądziel, M.; Figliè, R.; Mazzei, D.; Tyrovolas, M.; Stylios, C.; Navarro, J.; Solé-Beteta, X. Role of Academics in Transferring Knowledge and Skills on Artificial Intelligence, Internet of Things and Edge Computing. *Sensors* **2022**, *22*, 2496. [CrossRef]
55. Paśko, Ł.; Mądziel, M.; Stadnicka, D.; Dec, G.; Carreras-Coch, A.; Solé-Beteta, X.; Pappa, L.; Stylios, C.; Mazzei, D.; Atzeni, D. Plan and Develop Advanced Knowledge and Skills for Future Industrial Employees in the Field of Artificial Intelligence, Internet of Things and Edge Computing. *Sustainability* **2022**, *14*, 3312. [CrossRef]
56. Tedre, M.; Toivonen, T.; Kahila, J.; Vartiainen, H.; Valtonen, T.; Jormanainen, I.; Pears, A. Teaching machine learning in K–12 classroom: Pedagogical and technological trajectories for artificial intelligence education. *IEEE Access* **2021**, *9*, 110558–110572. [CrossRef]
57. Toivonen, T.; Jormanainen, I.; Kahila, J.; Tedre, M.; Valtonen, T.; Vartiainen, H. Co-designing machine learning apps in K–12 with primary school children. In Proceedings of the 2020 IEEE 20th International Conference on Advanced Learning Technologies, Tartu, Estonia, 6–9 July 2020; pp. 308–310.

58. Weerasekara, S.; Lu, Z.; Ozek, B.; Isaacs, J.; Kamarthi, S. Trends in Adopting Industry 4.0 for Asset Life Cycle Management for Sustainability: A Keyword Co-Occurrence Network Review and Analysis. *Sustainability* **2022**, *14*, 12233. [CrossRef]
59. Chen, Q.; Wen, Y.; Zhang, X.; Zhu, Z. Evolutionary Overview of Terrace Research Based on Bibliometric Analysis in Web of Science from 1991 to 2020. *Int. J. Environ. Res. Public Health* **2022**, *19*, 7796. [CrossRef] [PubMed]
60. Lis, A.; Sudolska, A.; Pietryka, I.; Kozakiewicz, A. Cloud Computing and Energy Efficiency: Mapping the Thematic Structure of Research. *Energies* **2020**, *13*, 4117. [CrossRef]
61. Khan, M.; Ibrahim, M.; Wu, N.; Patil, R. Interdisciplinary Project Based Learning Approach for Machine Learning and Internet of Things. In Proceedings of the IEEE Integrated STEM Education Conference, Princeton, NJ, USA, 1 August 2020; pp. 1–6.
62. Wu, Y.; Nouri, J.; Li, X.; Weegar, R.; Afzaal, M.; Zia, A. Catching Group Criteria Semantic Information When Forming Collaborative Learning Groups. In Proceedings of the 16th European Conference on Technology Enhanced Learning, Toulouse, France, 12–16 September 2021; pp. 20–24.
63. Fan, X.; Zhong, X. Artificial intelligence-based creative thinking skill analysis model using human–computer interaction in art design teaching. *Comput. Electr. Eng.* **2022**, *100*, 107957. [CrossRef]
64. Rossi, R. Catching Data Science Education Based on ADDIE Model and the EDISON Framework. In Proceedings of the International Conference on Big Data Engineering and Education, Guiyang, China, 12–14 August 2021; pp. 40–45.
65. Lameras, P.; Arnab, S. Power to the Teachers: An Exploratory Review on Artificial Intelligence in Education. *Information* **2022**, *13*, 14. [CrossRef]
66. Sanusi, I.T.; Olaleye, S.A. An insight into cultural competence and ethics in K-12 artificial intelligence education. In Proceedings of the IEEE Global Engineering Education Conference, Tunis, Tunisia, 18–31 March 2022; pp. 790–794.