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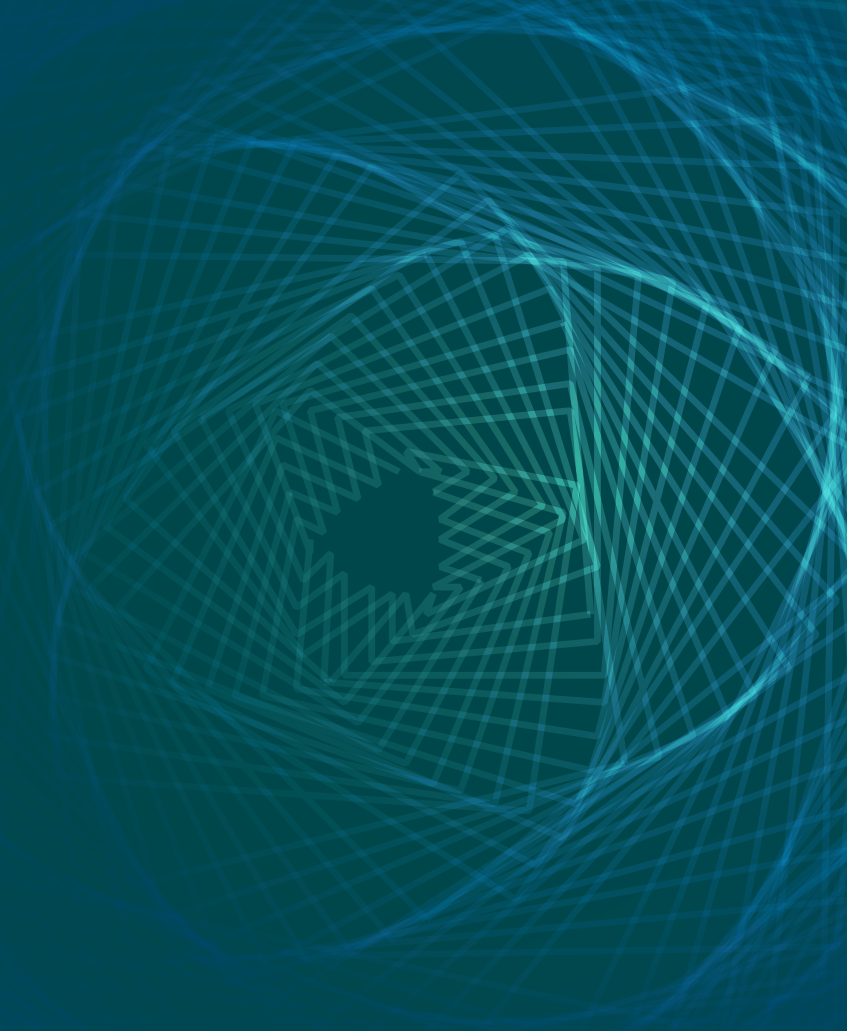

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Systematic Review of Artificial Intelligence in Higher Education (2000-2020) and Future Research Directions

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Abstract

The goal of this study is to synthesize the findings, methodology and research themes of peer reviewed studies on Artificial Intelligence in higher education, published between 2000 to 2020. Twenty-nine articles were selected for review by following the PRISMA approach. The demographical and thematic trends suggest that most research is skewed towards few geographical locations (USA, Europe, India, China, Hong-Kong) and recent time periods (2018-2020) and scattered across publications from varied disciplinary traditions. Taiwan and United States contributed most to the number of studies, with 2017 being the most fruitful year. Vectors as well as decision trees were the most often used machine learning algorithms. Mechanization, cognitive process assessment, prediction models, integrated learning systems, and tackling potential problems in the use of big data and learning analytics were among the most commonly explored topics. Expanding geographical variety, adopting advanced algorithmic approaches including Bayesian as well as fuzzy logic techniques in educational machine learning work; applications for knowledge-based systems, and personalized learning were suggested for future search. Conclusions are drawn and future research directions identified. Potential research recommendations emphasize the expansion of geographical, topical, and methodological variety.

Keywords: machine learning, educational data mining, learning system

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Introduction

John McCarthy coined the term "Artificial Intelligence" in 1955 to separate the endeavour from cybernetics and automata ideas (Nilsson, 2009). Artificial intelligence (AI), according to McCarthy, is “making a machine behave in ways that would be called intelligent if a human were so behaving” (McCarthy, Minsky, Rochester, & Shannon, 1955). The key to understanding artificial intelligence has been identifying artificiality's parameters, and also how computers differ from machine consciousness.

Machine Learning is one of the branches of AI that employs statistical approaches to make predictions based on observable patterns. In supervised learning, for example, a photograph or text is labelled (as an example) or categorised (as a concept) with labels added by the human "trainers."

In order to detect the same patterns in additional occurrences of the item, statistical approaches are applied. The computer identifies data patterns for unsupervised learning, and trainers are expected to categorise the text and graphics where these patterns appear (Zhai & Massung, 2016). Deep Learning as well as Neural Nets are multi-layered analytical sequences that identify patterns in patterns (Krizhevsky, Sutskever, & Hinton, 2012; Rumelhart, Hinton, & Williams, 1986), and they demand a lot of data and processing power. The bits 1 or 0 are substituted with qubits in quantum computing, where 0 and 1 are replaceable and definable as probabilities instead of definite integers (Feynman, 1982).Artificial intelligence is being used to replace current assessments and modify educational processes. Engagement through computer-mediated material resources, interactions between students and professors, and knowledge manifestations in the form of student work all fall under the umbrella of artificial intelligence. Learning includes AI-assisted evaluation. Students and teachers can use gradual performance monitors to help them create personalised or adaptable learning paths. (Cope & Kalantzis, 2015, 2016, 2019). Educational data mining is one of the burgeoning fields. (Castro, Vellido, Nebot, & Mugica, 2007) as well as learning analytics (DiCerbo& Behrens, 2014; Siemens, 2013). AI centred assessments are being included in some AI-enabled integrations such as : tutoring systems that are intelligent (Carbonell, 1970; Mark & Greer, 1995; VanLehn, 2011); Analyses of log files and clickstreams that predict learner success (Crossley, Paquette, Dascalu, McNamara, & Baker, 2016); On-the-fly-captured and interpreted incremental moves being captured and interpreted in games and artificial simulations. (Shute & Ventura, 2013); Text classification that looks for possible semantics in students' writing or verbally in basic language. (McNamara, Graesser, McCarthy, & Cai, 2014; Zhai & Massung, 2016); and machine-managed student evaluation (Balfour, 2013; Carlson & Berry, 2003; Kern, Saraiva, & dos Santos Pacheco, 2003). Prior studies of artificial intelligence in education really haven't explored how research is advancing or what areas of AI in education are being established and assessed. While there are several viewpoints and predictions about AI-based education, study and deployment of AI in education trails behind. The following are the study's research objectives:

- What are the dimensions and research themes of AI in higher education in literature
- What are the future research directions proposed for enabling implementation of AI in higher education

Methods

Articles were first extracted from well-known publishers' internet databases and web resources (Google Scholar, ERIC, Taylor & Francis Online, Wiley Online Library (Wiley-Blackwell), Science Direct/Elsevier, Springer Journals Database, Sage Journals) and then categorised using the PRISMA 2009 model (Figure 1.0)

The criteria included for selection of articles in this review were :

- Key words of “Artificial Intelligence”/ “Machine Learning” in “Education”/ “Higher Education”.
- Because earlier assessments on AI in Higher Education found no relevant papers before 2000, publications between 2000 and April 2021 were selected for consideration.
- (3) Papers Published in peer-reviewed and high quality (high impact factor) journals based on quantitative, qualitative, or mixed methods were only considered based on citation index of the articles and journal.

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- (4) Empirical research, literature reviews, meta-analyses, and conference proceedings that are Scopus indexed and published globally in English were all included in the study. A separate content analysis was conducted in addition to the term-based search to identify papers that did not fit the research's conceptual methodology.
- (5) Because this study was confined to peer-reviewed papers to increase the reliability of the review, books/book volumes, reports, dissertations, and other comparable documents/publications were excluded.
- (6) Descriptors of 'AI", "Artificial Intelligence", "machine learning" with "education", "Higher Education" were used for initial extraction of papers from databases.
- (7) The 29 primary studies (Table 1) selected for the study were categorized by two reviewers into three categories according to methodology of study i.e. Quantitative, Qualitative and Mixed methods (Table 4) and domain of application of AI in higher education i.e. Administrative application, Student applications and Tutor applications (Table 5).
- (8) A scriptural narrative synthesis approach (Xiao, 2017) is used, which is centred on realist review methods (Popay et al,. 2006) and (Lucas et al,. 2007),and involves an organised analysis and synthesis of various findings from reviewed articles, accompanied by a textual and word-based analysis to derive an overview and dissemination of results (Popay et al,. 2006).The end result is a summary of current literature and knowledge in relation to the research provided. This form of analysis allows researchers to focus on regions that have been understudied and can lead to new research directions (Varnali & Toker, 2010).However, because this system does not allow for a clear attribution of each article, several articles are addressed more than once. Each group is further subdivided and studied in depth in the subsequent subsections.

Figure 1: PRISMA 2009 Flow Diagram

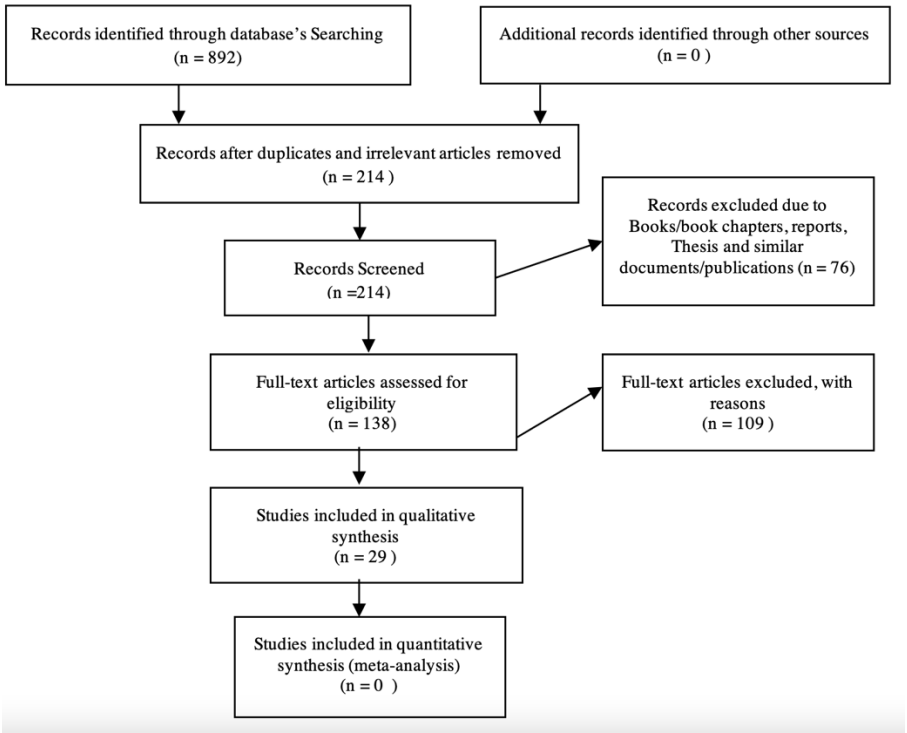

Table 1: Papers Chosen for the Review

No	Title	Author	Methodology	Country	Findings
1.	A multi-perspective study on Artificial Intelligence in Education: grants, conferences, journals, software tools, institutions, and researchers.	Xieling Chen, HaoranXie&Gwo -Jen Hwang 2020	Quantitative (Secondary Data)	Hong Kong	The study contributes to the field of research by allowing educators and academics to learn about the status and progress of relevant projects and publications related to AIEd. Further insights about active actors can assist teachers and scholars in identifying active researchers and institutes in AIEd research. Researchers and instructors are also better able to find relevant articles and are therefore more aware of important concerns in AIEd studies.
2.	Predictive Modelling to Predict the Residency of Teachers Using Machine Learning for the Real Time.	Chaman Verma1, Zoltán Illés and Veronika Stoffová. 2020	Quantitative (Primary Data)/Experimental design	Europe	The RF algorithm beat others in predicting teacher residency, according to a study. The CPU user time of SVM is notably different from that of others.
3.	Artificial intelligence for education: Knowledge and its assessment in AI-enabled learning ecologies.	Bill Cope, Mary Kalantzis & Duane Searsmith 2020	Quantitative And Qualitative	USA	The main conclusion is that artificial intelligence will never "take over" the position of teacher in the setting of embedded computing methods developed over the previous three quarters of a century, because how it operates and what it does are so fundamentally different from human intelligence. However, within the constraints outlined in this paper, it has the potential to revolutionise education in ways that, perhaps counterintuitively, make it more human, rather than less.
4.	Dropout and transfer paths: What are the risky profiles when analysing university persistence with machine learning techniques?	Luis J. Rodrı´ guez-MuñizI, Ana B. Bernardo, Marı´a Esteban, Irene Dıaz 2019	Qualitative	Europe	The paper highlights the importance of educational outcomes in the first year and the impact of personal and situational variables, but other factors are also highlighted with this framework, such as the significance of dedication (part-time or full-time) and the susceptibility of students due to their age. A detailed graphic output is also given to make it easier to understand the found rules.
5.	Dropout early warning systems for high school students using machine learning.	Jae Young Chung, Sunbok Lee 2018	Quantitative (Primary Data)	USA	In terms of several performance measures for binary classification, the predictive model performed exceptionally well in predicting student dropouts. The findings of the research show the value of applying machine learning with student big data in the classroom. A brief review of machine learning in general and the random forest model in particular, as well as the many performance indicators used to assess our predictive model is provided.
6.	Machine Learning Based Student Performance Analysis System.	R.Karthikeyan, S.Satheesbabu , P.Gokulakrishnan 2021	Qualitative	India	The system includes the Python language and the Anaconda IDE to handle raw table data using Random Forest Algorithm, Logistic Regression Classifier, and Stochastic Gradient Descent Classifier. The data is analysed based on a variety of criteria, including romantic status, alcohol use, parental education level, frequency of going out, desire for higher education, and urban vs. rural pupils. Data Pre-Processing, Transformation Of data, Data Cleaning, and Divide & Testing with Training Dataset are some of the modules included in the process. Each model produces a unique result, and the best model is chosen as the final result.
7.	Exploring Machine Learning Methods to Automatically Identify Students in need of Assistance.	Alireza Ahadi, Raymond, Lister HeikkiHaapala and ArtoVihavainen 2015	Quantitative	USA	From a variety of perspectives, having early information on a student's performance is advantageous. Instructors might present more hard tasks for high-performing pupils and target their help to struggling students early on. Furthermore, students who underperform in the initial programming course, yet pass can be closely observed in their subsequent courses.
8.	Study Of Students' Performance Prediction Models Using Machine Learning.	Mr. S. Viswanathan and Dr. S. Vengateh Kumar 2021	Qualitative	India	Student performance prediction, as well as to present the findings of a study aimed at evaluating the performance of various data mining classification algorithms on the given dataset in order to assess their potential usefulness for achieving the goal and objectives.
9.	Different Machine Learning Models to predict dropouts in MOOCs.	Avinash Kashyap and Ashalatha Nayak 2018	Quantitative	India	Data research reveals a strong link between the amount of click events, video views, and blog posts, as well as the successful learner's result. On the dataset from HarvardX, Machine Learning algorithms are implemented, and the results show that Random Forest produces the best results with the best performance.
10.	Artificial Intelligence in Education: A Review.	LIJIA CHEN, PINGPING CHEN, AND ZHIJIAN LIN 2020	Qualitative	China	The goal of this research was to assess the impact of artificial intelligence on schooling. A qualitative research study was conducted, with a literature review as the research design and method. Journal papers, research papers, and professional conference summaries were selected and employed in an analysis to help the study's goal be realised. The development and usage of technology paved the way for research and breakthroughs that led to the creation and application of artificial intelligence (AI) in several fields.
12.	Discrimination of the Contextual Features of Top	Jiangping Chen & Yang Zhang	Quantitative	China	According to the findings, the quality of teachers' teaching methods, parents' academic/ occupation status, discipline

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No	Title	Author	Methodology	Country	Findings
	Performers in Scientific Literacy Using a Machine Learning Approach.	&Yueer Wei1 &Jie Hu 2019			climate, duration on and engagement in learning, schools' mass media facilities/equipment, the number of teachers, and students' self-efficacy all played important roles in the intended students' superior achievement in class. Future studies on students' scientific literacy performance may benefit from the characteristics found in this review.
13.	Application and theory gaps during the rise of Artificial Intelligence in Education.	Xieling Chen, HaoranXie, Di Zou, Gwo-Jen Hwang 2020	Qualitative	Hong Kong	Scholars can look into the possibility of using AI in physical classrooms; give greater attention to the application of digital deep learning algorithms like generative adversarial and convolutional neural networks; and look into the possibility of using natural language processing to promote precision or personalised education. They can combine biological detection and optical imaging, such as electroencephalogram, with theoretical perspectives to target issues involving learners during the learning process; and tightly integrate the use of AI technologies with educational theories.
14.	Artificial intelligence innovation in education: A twenty-year data-driven historical analysis.	Chong Guan, Jian Mou and Zhiying Jiang 2020	Qualitative	South Korea	The paper's findings suggest a shift away from traditional tech-enabled educational design research and toward student profile models and cognitive insights.
15.	Artificial Intelligence Impacts on Higher Education.	Yizhi Ma and Keng L. Siau 2018	Qualitative Study	USA	This research examines the effects of AI on higher education. And what role higher education can have in AI development.
16.	Artificial Intelligence in education: Using heart rate variability (HRV) as a biomarker to assess emotions objectively.	Joanne Wai Yee Chung , Henry Chi Fuk So, Marcy Ming Tak Choi, Vincent Chun Man Yan and Thomas Kwok Shing Wong 2021	Quantitative Study	Hong Kong	It is possible to assess feelings using HRV as a biomarker as well as the PLS-DA as a sentiment classifier. LF, HF, the LF/HF ratio, SDNN, RMSSD, and pNN50 are all linked to happiness and sadness and assist educators in detecting students' emotions (joy and despair) during class so that they can alter their instruction accordingly.
17.	Artificial neural networks in academic performance prediction: Systematic implementation and predictor evaluation.	Carlos Felipe Rodríguez-Hernandez, Mariel Musso, Eva Kyndt, Eduardo Cascallar 2021	Quantitative	Colombia	In assessment methods such as the recall and F1 score, artificial neural networks outperform existing machine-learning methods. Previous academic success and students' academic achievement in higher education is heavily influenced by their socioeconomic circumstances and high school features.
18.	Artificial Intelligence trends in education: a narrative overview.	Maud Chassignol, Aleksandr Khoroshavin, Alexandra Klimova and Anna Bilyatdinova 2018	Qualitative	Russia	The study discusses the effects of artificial intelligence on education and offers a viewpoint on the subject. It also discusses how AI may aid in decoding student challenges and in determining how to assist them. AI may also help in improving collective imagination and designing a new learning experience. Even while AI will not totally replace our old educational system, it is transforming and reshaping the learning process.
19.	Education 4.0 - Artificial Intelligence assisted Higher Education: Early recognition System with Machine Learning to support Students 'Success.	Monica Ciolacu , Ali Fallah Tehrani, Leon Binder, and Paul MugurSvasta 2018	Quantitative	Germany	The goal of this case study was to forecast students' final grades before they take the final test. An Early Recognition System based on Auto Lecturer by N. A. Crowder theory with adaptive self-assessment responses, and an adaptive learning environment based on Auto Tutor by N. A. Crowder hypothesis with adaptive self-assessment feedback in a collaborative learning course with a personalised test is recommended at the beginning of the semester. Focusing on students' success and achievements is a win-win situation for students, professors, and the management.
20.	Comparison of learning analytics and educational data mining: A topic modelling approach.	David J. Lemay, Clare Baek, Tenzin Doleck 2021	Quantitative	USA	The trend indicates a consolidation in educational research on the use of sophisticated analysis learning approaches to derive meaningful insights from large data for education - learning optimization. Over the last five years, both areas of learning analytics and EDM have converged with a greater emphasis on student behaviour.
21.	Prediction of Students Performance using Machine Learning.	J. Dhilipan, N.Vijayalakshmi, S.Suriya, Arockiya Christopher 2020	Quantitative	India	The research used machine learning techniques to analyse student academic growth. For the purpose of research, the classifiers of Binomial logical regression, Decision tree, Entropy, and KNN were employed. The procedure can assist the instructor in making more informed decisions regarding the students' performance and scheduling more effective methods for boosting their academics.
22.	Machine Learning-Based App for Self-Evaluation of	Fedor Duzhinand Anders Gustafsson 2018	Quantitative	Singapore	The methodology (machine learning-based evaluation of non-experimental data) and the fact that efficacy of clickers versus handwritten homework in evaluation of result of learning math are both innovative aspects of the findings. Active

No	Title	Author	Methodology	Country	Findings
	Teacher-Specific Instructional Style and Tools.				teamwork tended to benefit pupils more than individual work. The algorithm was put into an app and provided to the educational community, allowing practitioners to utilise it without having specialised methodological expertise.
23.	Enhancing Efficient Study Plan for Student with Machine Learning Techniques.	Nipaporn Chanamarn and KreangsakTamee 2017	Quantitative	Thailand	37 students were used as survey data to classify their clusters and predict their CGPA. By using self-adaptive learning in accordance with the study plan chosen, the samples' CGPA improved significantly.
24.	Novel machine learning technique for predicting teaching strategy effectiveness.	Natalia Kushik, Nina Yevtushenko and Tatiana Evtushenko 2016	Quantitative	Russia	The ideal (online) teaching technique should be determined by the aims, individual characteristics, needs, and preferences of the pupils..
25.	Early prediction of college attrition using data mining.	Luiz Carlos B. Martins, Rommel N. Carvalho, Ricardo S. Carvalho, M´arcio C. Victorinoand Maristela Holanda 2017	Quantitative/Experimental	Brazil	The study used H2O software as a data mining tool and parameter adjustment to train 321 of three classification algorithms, and Deep Learning,
26.	Evolution and Revolution in Artificial Intelligence in Education.	Ido Roll & Ruth Wylie 2016	Qualitative	Canada	AI is an evolutionary process focusing on existing classroom practises, interacting with teachers, and expanding the range of technologies and domains.
27.	Out of the laboratory and into the classroom: the future of artificial intelligence in education.	Daniel Schiff 2020	Qualitative	London	The status of AIEd is assessed in this study, with a focus on effective teaching and anthropomorphized artificial teaching agents.
28.	Edu-mining: A Machine Learning Approach.	Prof.Dr. P. K. Srimani, Mrs. Malini and M. Patil 2011	Quantitative	India	The purpose of of this work is to design a technique called Edu-MINING, which uses data mining techniques to convert the raw information from academic institutions into relevant information.
29.	Student Performance Prediction using Machine Learning.	Mrs. AksheyaSures; BalaSubramaniyan S; Eswar Kumar R; Gokulkumar N 2020	Qualitative	India	Students' efficiency is investigated using various classification algorithms, with the top one yielding the best findings.

Table 2: Year Wise Distribution of Publications

Year	Frequency
2015	1
2016	2
2017	2
2018	5
2019	2
2020	11
2021	6

Findings

The evaluation of the selected 29 articles indicated following emerging trends as regards context, year, journal type, methods and themes used in the studies.

Demographic trends indicate that most of the studies have been conducted 2018 onwards (Table 2). For example, 24 (above 75% of the papers selected) studies were published between 2018 and 2021 which shows a significant upwards trend in scholarly interest in the field. AI in educational research has been studied and published in journals from disparate perspectives (Table 3) which has precluded the development of an integrated perspective and research approach.

Table 3: Journal Wise Distribution of Publications

Name of the Journal	Frequency
Computers and Education: Artificial Intelligence	5
International Conference on Futuristic Trends In Network and Computing Technologies	1
Education Philosophy and Theory	1
Plos One	1
Children and Youth Services Review	1
Information Technology in Industry	1
Proceeding in 11th annual international conference on international computing educational research	1
Turkish Journal pf Computers and Mathematics Education	1
International Conference on Advances in Computing Communications and Informatics	1
IEEE Access	3
Education and Information Technologies	1
Research in Science Education	1
International Journal of Innovation Studies	1
Association for information system	1
7th International Young Scientist Conference on computational Science	1
IOP Conference series: Materials and Science Engineering	1
Education Sciences	1
International Journal of modern education and computer sciences	1
International Journal of Information Management	1
International journal of Artificial Intell Education	1
Artificial Intelligence and society	1
International Journal of computer sciences and mobile computing	1
AIP Conference Proceedings	1

Europe, USA, Hong Kong and China take the lead as regards geographical concentration of the studies with few publications from Canada, Russia, Brazil, Singapore, Columbia, Kuwait, South Korea and Thailand (one each), (Table 1) Thus while AI in education is fast gaining attention of scholars, there is lack of integration and uniformity in the research approaches with most studies being defined by the availability and access to data. There is a preponderance of studies using quantitative methods followed by qualitative analysis. Only one paper was based on mixed methods thus indicating a polarization in methodological approaches (Table 4).

Table 4: Classification of Studies According to Methodology

Qualitative Method	J. Rodrı´ 2019, .Karthikeyan, 2021, S. Viswanathan 2021, Lijia Chen 2020, S. Alenezi 2020, Xieling Chen 2020, Guan 2020, Yizhi Ma 2018, Chassignol 2018, NipapornChanamarn 2017, Ido Roll 2016, Daniel Schiff 2020, Aksheya Suresh 2020
Quantitative Method	Chen 2020, Verma 2020, Jae Young 2018, Alireza Ahadi 2015, Avinash Kashyap 2018, Jiangping Chen 2019, Chung 2021, Carlos Felipe 2021, Ciolacu 2018, J. Lemay 2021, J. Dhilipan 2020, Anders Gustafsson 2018, NipapornChanamarn 2017, Natalia Kushik 2016, Carlos B 2017, Srimani 2011,
Mixed Method	Bill Cope 2020

Conclusions and Implications

The papers under review reveal that AI in higher education is still in its early stages of development, with the majority of studies focusing on computation algorithms that anticipate student and teacher effectiveness or retention rates from data structure so that early interventions may be implemented.

Plenty of the studies have been focused on building and testing machine learning algorithms that predict academic performance well as dropout rates. The main motivation is to identify individual students who are likely to drop out or fail the course, so that early detection can help them. The majority of studies are working to improve the accuracy, responsiveness, and precision of machine learning algorithms so that early intervention can be planned (Table 5)

Table 5: Classification of Selected Papers According to Domain of Application of AI in Higher Education:

Administrative	Student	Teacher
Luiz Carlos B. Martins, 2017(prediction of college attrition)/ Avinash Kashyap, predicting drop outs in MOOCS)/ Chaman Verma, 2020 (predicting residency of Indian university teachers)/ Jae Young Chung a and Sunbok Leeb (drop out early warning systems)/ Alireza Ahadi and Raymond Lister, 2015 (identifying high and low performing students); Martins, 2017(early prediction of college attrition using data mining); Luis J. Rodrı´, 2019(Drop out and transfer plans); Jae Young Chung, 2018 (predictive model in students drop out rate)/ Alireza Ahadi, Raymond, Lister Heikki Haapala and Arto Vihavainen- (predicting SP for identifying those in need of assistance);S. Viswanathan, 2021(Student performance prediction models); Carlos Felipe Rodríguez, 2021	R. Karthikeyan, S. Satheesbabu , P. Gokulakrishnan/ Jae Young Chung, Sunbok Lee/Mr. S. Viswanathan and Dr. S. Vengateh Kumar, 2021/Nipaporn Chanamarn, 2017; Vincent Aleven, Intelligent Tutoring systems; Nipaporn, 2017 (self - adaptive learning plans)	Mary Kalantzis& Duane Searsmith/ Fedor Duzhin, 2018 (Self-Evaluation of Teacher-Specific Instructional Style and Tools); Natalia Kushika, 2017(predicting Teaching strategy effectiveness); Joanne Wai Yee Chung, 2021(using HRV as a biomarker and the PLS-DA as an emotion classifier to assess emotions of students); Natalia Kushik, 2015 (predicting teaching strategy effectiveness); P. K. Srimani (Edu-Mining); J. Dhilipan, 2020(predict student academic performance)

The reviewed studies adopted five different perspectives to the drop - outs phenomenon (Tinto, 1985), namely, psychological, sociological, economic, organisational, and inter-actionist strategies, as well as a sixth method, the integrationist or holistic attitude, which takes into account the influence of all of the above frameworks, connecting previous and present academic experiences, and emphasises the crucial role of prior and current educational life.

Scholars have utilised a variety of data analysis approaches, such as correlational analysis, univariate or multivariate variance evaluation, regression analysis and structural equations, and multilevel analysis, which makes it challenging for stakeholders to evaluate the results. Machine Learning (ML) methods and data mining techniques (Educational Data Analysis) (EDA) are the most popular research topics, however there are few studies that use EDA in the context of dropping out over a university's full degree programme. While most machine learning research has attempted to predict students' grades or course continuation, they have been constrained by the lack of vast data from all degree courses at a single university.

The majority of theories either focus on narrow perspectives on cognition or completely neglect the political, psychological, and philosophical dimensions of intelligence. AI solutions are being investigated for tasks that can be automated, but they are not yet envisioned as a solution for more complicated higher learning jobs.

As a result, while AI is not yet ready to replace teachers, it does have the potential to supplement them. The impact of computing algorithms on student and instructor performance and retention is the subject of research, though AI as a solution or replacement for excellent pedagogical methods or good teaching is not yet a subject of scholarly interest.

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Furthermore, AI software based on complicated algorithms built by programmers who can convey their own biases or objectives in operating systems may substitute many of the duties that are currently at the core of teaching practise in higher education.

Future Research Directions

Future research could apply EDA to specific domains such as university degree programmes, open or digital college courses, e-learning, MOOCs, and integrated learning programmes to develop deeper insight. To evaluate and implement the best method for predicting teachers and students' efficiency and retention/drop-out levels, various concepts can be used within EDA techniques which are based on ML: lazy techniques such as KNN, strategies based on tree construction, classification and regression trees, or Cognitive and Bayesian networks.

"The walls between humans and AI systems are slowly beginning to erode, with AI systems augmenting and enhancing human capabilities. Fundamental research is needed to develop effective methods for human-AI interaction and collaboration" according to US President Barack Obama in October 2016. To establish successful ways for human-AI interaction and collaboration, foundational research is required" (U.S. National Science and Technology Council 2016). Future study into AI as a tutoring or educational solution will open up new options and opportunities. Technology's function in higher education is to improve public cognition and enrich the educational process, not to limit it to a set of material transmission, control, and evaluation processes.

Recent advances in non-invasive brain-computer interface and artificial intelligence may offer new avenues for rethinking the role of teachers or paving the way for teacher-robots, or virtual "teacherbots" (Bayne 2015; Botrel et al,. 2015).Further studies into application areas in teaching and learning, such as personalised learning using a teacherbot, or 'cloud-lecturer,' for hybrid delivery courses or wholly online courses, is possible. Teacherbots, which handle the administration aspects of education, such as content delivery, fundamental and administrative comments, and monitoring, can be a disruptive replacement for traditional adjunct professors.

AI solutions that can tailor the 'feed' of data and knowledge into the course to the needs of the students, as well as provide feedback and encouragement, are being investigated. For improved student- centred learning, AI technologies that monitor our choices, preferences, and movements, assess advantages and disadvantages, offer suggestions, encouragement, badges, comparable analytics, tailored news feeds, alarms, and predictive text might be investigated and created.

The future research directions might be focused on AI solutions that emulate teachers, permit student diversity, and stimulate socio-emotional engagement. Scholars can concentrate on using AI in physical classrooms, as well as for advanced deep learning algorithms like generative adversarial networks and deep neural networks, and explore the potential of natural language processing in improving precision or individualised instruction.

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