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Original Contribution

Expansion of Machine Learning Employment in Engineering Learning: A Review of Selected Literature

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Articles were summarized and analyzed by the author based on the year of publication and the context in which the article was published, among other factors. The purpose of this study is to determine the progress made in the implementation of machine learning in a variety of engineering fields. The research approach employed was a literature review, and secondary data was gathered from renowned international journals that were indexed by Google Scholar during the process. As a result of the findings, machine learning has been widely implemented in engineering education across fourteen domains, with one of the most significant being Prediction Student Academic Performance, which has shown constant progress from 2013 to 2018. Furthermore, the total number of engineering majors who are implementing machine learning is thirteen majors in total. According to the expectations of the researchers, this research will serve as an illustration, reference, and consideration for technicians in engineering education to pay greater attention to, and it will be applicable in schools, universities, and other engineering institutions throughout the country of Indonesia.

INTRODUCTION

The Fourth Industrial Revolution (sometimes known as the Fourth Industrial Revolution) has prompted a tremendous upheaval in the realm of education [1]. It was determined that this shift was associated with the elimination of work that was considered wasteful, automated, or digitalized [2] [2. Examples of changes can be observed in the inclination of students to learn, where the selection of instructional media becomes the primary focus of the students' attention when carrying out their learning activities, for example. In accordance with that notion, digital technology presents new problems for traditional education, from the primary to the higher levels [3]. That is to say, the construction of intelligent systems [4] is the task at hand. That intelligent systems are a component of the digital 4.0 revolution, which includes big data, cloud computing, data analytics, artificial intelligence, machine learning, Internet of Things systems, adaptive robots, virtualization, and additive manufacturing [2]. For the general public, every component of the Fourth Industrial Revolution (4.0) has become a source of anxiety, particularly the element of machine learning [5].

Machine learning is a component of the digital revolution. In the fourth generation, technology can learn without being explicitly programmed [6]. Education in the domains of science, technology, engineering, and mathematics has the potential to be transformed by machine learning [7]. One example is the education process, which includes the function of the instructor as a mentor, as well as the automation of all administrative activities associated to education [8].

Machine learning has been dominated by engineering education in the departments of

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electrical engineering and computer engineering since 2018, according to a recent study [2]. Despite this, according to Dimiduk et al. in their research on the perspectives of machine learning influence, an engineering practitioner in the field of engineering education was regarded to be very slow in his involvement in the digital revolution 4.0 [9]. It has also been reported that in engineering education, several colleges do not teach about the components of the Digital 4.0 Revolution curriculum [2], as Onar and colleagues have stated. Furthermore, it has been reported that when McKinsey & Company questioned 300 key leaders in Southeast Asia, they asked them if they were prepared to handle the Fourth Industrial Revolution (4.0). In the end, the data revealed that 48 percent of those who took part said they were prepared. Evidence or work created by numerous researchers connected to the application of machine learning in the field of education, specifically in engineering education, must be used to determine whether or not a researcher is ready to proceed.

Through literature studies, the researchers have furthered their understanding of machine learning in the field of education, which they conducted in 2013, 2017, and 2018. According to Chrysafiadi and Virvou, a literature review was conducted on student modelling [11]. There is a literature review on prediction systems to find out students who have been expelled from their schools [12] and a literature review on decision-making systems [13]. Dalipi and colleagues conducted a literature review on prediction systems to find out students who have been expelled from their schools [12]. Bacos, a review of the literature on the quantified self, affective computing, emotional design, and pedagogical agents [14], is available online. Suhaimi et al. conducted a study of the literature on prediction algorithms to determine when children will graduate from high school [15]. Finally, Kuak et al. and Korkmaz & Correia conducted a review of the literature on the growth of machine learning in education [16,17] before concluding.

In the end, the author comes to the conclusion that machine learning in the field of education is still in the early stages of development. However, the writers were unable to locate a comprehensive overview of literature that analyzes the growth of machine learning in engineering education, which was particularly requested by the authors. That knowledge about digital revolution 4.0 technology is still developing until now needs to be known, give an overview for technicians in engineering education, and prepare themselves in the face of the digital revolution 4.0. Therefore, in this study, the authors have aim to determine the development of the implementation of machine learning in several engineering majors from 2015 to 2018 through a literature review.

METHOD

In this study, a systematic review was carried out as the research approach. In addition, a meta-analysis [18] was used for data analysis purposes. Several publisher sources, including IEEEXplore, SpringerLink, Science Direct, and ERIC, as well as Google Scholar, were used to gather secondary data for this study. The articles were found through search engines in several publisher sources, including IEEEXplore, SpringerLink, Science Direct and ERIC, as well as additional assistance from Google Scholar. When searching, the author used five keywords, which include student prediction, student accomplishment, student performance, machine learning in education engineering, and machine learning in student assessment, amongst others. The inclusion criteria in Table 1 show the limits that are applied when searching for articles, and they can be seen as a result.

Table 1: Lists the requirements for an article's presence

No	Inclusion
1	Articles type are Journal and indexed by Google Scholar
2	Articles language is English
3	Articles not contain a blank page
4	Concerned with engineering and applying machine learning
5	Respondents from engineering education
6	Some articles is “in manuscript form are accepted”
7	Using machine learning methods

In general, the second inclusion requirement specified limits the number of articles that can be written in English. This is related to the paper that the author found in the IEEExplore database, which is articles not in English language, one example like Amaya et al. [19] article, that article title is in English, but the content is not in English. Then, the third inclusion criteria are the existence of the article found in the IEEExplore database, which is published as a new year in 2018, one example like Passey, article [20] where the article is blank, not contain content, but only abstract. As evidenced by the responses [20], the authors assumed that papers in machine learning would be related to engineering, which was the fifth of the inclusion criteria [20]. A manuscript that has been

accepted for publication was used to determine the inclusion of articles in the sixth inclusion criterion [21]. Articles were discovered by searching for accepted manuscripts in the ScienceDirect database. The publications employed a machine learning approach rather than an artificial intelligence algorithm method, according to the seventh of the inclusion criteria [22]. If the article obtained is of the Conference Proceeding type, not in English, contains only the title and abstract, is not related to engineering, is a peer review manuscript, and uses the usual algorithm artificial intelligence, as explained in the exclusion criteria, then that article should be avoided for download as a result of its inclusion in the list.

RESULTS AND DISCUSSION

Based on the supplied keywords, the author provides a breakdown of articles into four categories: the total number of articles found, the total number of articles downloaded, the total number of articles picked, and the total number of articles taken. Articles written by authors that have a high level of significance for education and machine learning approaches have been downloaded by other authors. Error! Contains a detailed overview of four different aspects. There was an error locating the reference source.

When thirty articles have been taken, seventeen articles have a problem, and the problem was the number of responses received. Some of the interviewees did not have a formal engineering education. In addition, two articles are not included in the SCOPUS index. The authors are well-known thanks to the Scimago Journal and the Country Rank website. As a precaution, the writers began searching for nineteen papers in Google Scholar using the same keywords to see if they would encounter a similar problem. Afterwards, nineteen papers were discovered, with contributions from a variety of publishers, including Semantic Scholar, MDPI, and Research Online Goldsmiths of the University of London, ACM Digital Library, and SAGE Journal. However, when the author's review was completed, one paper was identified as duplicate, three articles were identified as not being relevant to machine learning, and three articles were identified as not being relevant to engineering. As a result, there are a total of 23 articles.

In the year 2015, there was only one article published on the site. That amounted to 4,347 percent of the total. Then, in 2016, the number of articles dropped to three from the previous year. That represented a percentage of 13.04347826 percent. From 2017 to 2018, there was an increase in the number of articles, which went from five articles in 2017 to seven articles in 2018. That ranged from 21.73913043 percent to 30.43478261 percent, with the average being 21.73913043 percent. Meanwhile, from 2017 to 2018, there was no increase in the price. Four types of authors were created for each scenario, with the categories comprising of prediction; academic; automation; and others. There are four categories to consider:

Prediction

Student Action (1 article) in the Department of Forestry Engineering, Student Academic Performance (10 articles) in the Department of Engineering, Electrical Engineering, Mechanical Engineering, and Aerospace Engineering, Computer Engineering, Information Technology, Vocational Student, Student Placement (1 article) in the Engineering department using the WEKA (Waikato Environment for Knowledge Analysis) dataset, and Educational Input (1 article) in the Department of Forestry Engineering were included in the context that contains predictions. Thirteen articles are included in the forecast category, for a total of thirteen articles.

Academic

There are two articles in the Engineering Sciences major that deal with academic decision-making: Academic Guidance (1 article) and Academic Decision (1 article). The context that contains academic decision-making appears in the Industrial, Systems, and Electronic, Electric, and Cadastral Engineering majors. In the academic category, there are a total of two publications published in total.

Automation

Machine Assessment (1 article) in the Software Engineering department, Automatic Analysis (1 article) in the Engineering department, and Automatic Scoring (1 article) in the Chemical, Electrical, and Computer Science Engineering department were all included in the context that involves automation. The total number of articles in the category of automation is three articles in total.

Others

Mining Data (1 article) in the Engineering Department, Multimodal Learning Analytics (1

article) in the Engineering Department, Machine Learning Education (1 article) in the Engineering Department in STEM Education, Ethics in Machine Learning (1 article) in the Engineering Department is majoring in Engineering, and Student Collaborative (1 article) in the Department of Engineering were all included in the context that contains information about other individuals. The total amount of articles in the category of automation is five articles in total.

In order to determine which articles were published in a given year, the authors arrange each setting of the article together according to the year in which it was published. The divisions are as follows:

- Academic performance of students in 2014
- 2015: academic performance of students, student activism, and data mining
- Student academic performance (3 articles), automated scoring, and multimodal learning analytics were all covered in the year 2016.
- 2017: machine assessment, academic decision, academic guidance, educational institution, student academic performance, student placement, student collaboration, and student collaboration.
- Student academic performance (four articles), automated analysis, machine learning education, and ethics in machine learning were among the topics covered in 2018.

As we've seen, most research on predicting student academic achievement is done in 2018. Adusumalli [17] explained that forecasting student academic achievement began in 2013. Yildiz et al. [23] employed a fuzzy logic technique to predict student academic success. The fuzzy logic accuracy was 72%.

Fuzzy logic was not a machine learning technique. So, in 2014, authors couldn't find a review study on forecasting student academic success. So, according to authors, machine learning deployment in forecasting student academic achievement will begin in 2015. Kucak et alliterature .'s review explained the principle of studying student weaknesses using technology and then suggesting a method to improve student performance [16, 10]. The author found an article by Yagci & Cevik to forecast academic performance of vocational high school pupils in Johor Bahru, Malaysia, and Karaman, Turkey. The method used was Artificial Neural Networks (ANN). The results suggest that 98% of the system can be anticipated [24].

CONCLUSION

Forestry Engineering is one of thirteen engineering majors offered at the university, with the others being electrical engineering, electronic engineering, mechanical engineering, aerospace engineering, computer engineering, industrial engineering, systems engineering, Cadastral engineering, sciences engineering, software engineering, chemical engineering, computer science engineering, and computer engineering. In addition, engineering institutions such as Information Technology, Vocational Student, Technical and Vocational Institutions are a source of employment. There were seven studies that were not specifically indicated in which engineering department they were conducted. Four articles were not clearly addressed in the Prediction Student Academic Performance context, which is the engineering department, as well as the Prediction Student Academic Performance context. Sixty-six articles were reviewed for inclusion in the study, which resulted in fourteen contexts. These contexts were as follows: prediction student action; prediction student academic performance; prediction student placement; prediction educational institution; academic decision; academic guidance; mining data; multimodal learning analytics; machine learning education; ethics in machine learning; student collaboration; and machine learning education; ethics in machine learning According to one source, the accuracy of the Artificial Neural Network technique is 98 percent when compared to the accuracy of the fuzzy logic method, which is only 72 percent when compared to the accuracy of the non-machine learning approach (which is fuzzy logic). As a result, technicians in engineering education are expected to take the context and method into consideration when applying their knowledge in schools, colleges, and other engineering institutions throughout Indonesia.

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