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# ARTIFICIAL INTELLIGENCE IN EDUCATION – WHERE ARE WE NOW?

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## Abstract

There has been a lot of talk about artificial intelligence (AI) in education recently. However, the utilization of AI in an educational context does not always seem to match with application in a general context. While we are seeing great advances in the development of AI in self-driving cars, facial recognition or computers excelling in chess, the development of intelligent teaching assistants may seem to be lacking. In this article, we take a look at the current state of utilization of AI in an educational context. For this, we reviewed the current literature about artificial intelligence specifically in education. Ten high quality educational journals, with five having special focus on technology, were selected for the review. Based on the review, it seems that artificial intelligence is still mostly covered from a technical point of view, as there were only a handful of articles found in purely educational journals. The main focus seems to be on case studies and in including AI based courses in curriculum, followed by meta studies and critical reviews. Surprisingly, there were only a couple of articles about the ethical concerns of using AI in education, while in general the ethics of AI seems to be quite a popular topic. The total number of articles written about AI in education seems to be nevertheless increasing each year, which seems to be in line with the general interest of AI.

***Keywords:*** *AI, artificial intelligence, meta study, literature review, technology.*

## 1. Introduction

Artificial intelligence (AI) is a topic that is frequently mentioned in the context of education. Typically the discussion is either about how AI can and will change how we teach and learn (eg Kangasharju, et al. 2022; Gayed, et al. 2022) or how the substance we are teaching should be changed to correspond to the changed needs and requirements for the future workforce (eg. World Economic Forum, 2020). AI is already widely used in numerous applications. For instance, most smartphone users have an AI assistant in their pockets. We are living the fourth wave of AI, where deep learning is the big leap from previous technologies (Jaakkola, et la. 2019). In education there are a lot of promises and expectations. AI has been the hot buzzword in the commercial field for several years and it is often seen as an intrinsic value instead of a tool that it is. There doesn't seem to be many widely spread commercial solutions reclaiming these promises either. However, there are many interesting case studies and pilots that do show promising results but the adaptation of these solutions seem to be far from the promises. (Jaakkola, et al. 2020). There is also a lot of discussion and research around the use of AI in education from the perspective of various stakeholders (e.g. Borenstein & Howard. 2021; Garrett et al. 2020; Holmes et al. 2021; Latham & Goltz. 2019).

In this paper we observe the current state of discussions around AI in the top journals in the field of education and technology according to their H5-index. We aim to find the current trends in AI in education, the tone of voice of researchers towards AI in education and possible solutions that could be adapted by educational institutions.

## 2. Method

The study was conducted as a meta study. We decided to focus on the following research questions:

1. How is AI in education currently addressed in the top scientific journals of technology and education?
2. Are there differences in attitudes towards AI in education between educational technology journals and education journals?

We narrowed the search down to 5 journals focusing on technology and education and 5 journals focusing on education without a technological view. The decision of journals was made by their H5-index according to Google Scholar (Google 2022). The list of journals is displayed in Table 1.

*Table 1. The ten journals selected for the literature review, their types and H5 index at 2020 according to Google Scholar.*

| Journal | Type | H5-index |
|---|---|---|
| Computers & Education | Technology | 109 |
| British Journal of Educational Technology | Technology | 62 |
| Journal of Educational Technology & Society | Technology | 54 |
| Education and Information Technologies | Technology | 52 |
| Educational Technology Research and Development | Technology | 47 |
| Review of Educational Research | Education | 67 |
| Journal of the Learning Sciences | Education | 32 |
| Developmental Review | Education | 96 |
| Teaching and Teacher Education | Education | 83 |
| American Educational Research Journal | Education | 51 |

## 2.1. Procedure

The articles were searched for with search terms “artificial intelligence” and “AI”. In each case, we used the search provided by the journals’ websites. One exception was “Journal of Educational Technology & Society” where the search returned obviously incomplete results. In that case we manually browsed all articles between selected years.

From all journals, the articles included in the study were chosen according to following criteria:

1. The content of the article should be about artificial intelligence in education.
2. Article should have been published between 2020 and 2022.
3. Article should be peer-reviewed.

Hence, we excluded articles that contained AI (or similar terms such as machine learning or deep learning) in the title, but where the content was obviously about something else. The third criteria meant that we excluded for example editorial comments and forewords as well.

## 2.2. Analysis

A total of 109 articles were included in the study. The articles were classified according to the following classification:

1. Case studies of adapting AI-based tools in education.
2. Enthusiastic attitudes towards the possibilities of AI in education.
3. Critical reviews of AI in education.
4. The future predictions of what AI may provide in the future for education.
5. Ethical concerns about AI in education.
6. Meta study or literature review.
7. Studies about including or using AI education in curriculum.

The original list of categories was slightly modified after browsing the articles. The original eighth category (Surveys about using AI in education) was combined with category seven.

## 3. Results

Our initial search yielded 404 results with the search term “artificial intelligence” between the years 2020-2022 in the journals listed. Out of these 404 results, the total number of articles that were found to be about AI was 110. The number of results from journals focusing on technology and education was 107 (97.27%) and the number of results from journals without a technology emphasis was 3 (2.73%). Our results indicate that the largest individual category across all journals was category 1. Case studies of adapting AI-based tools in education with 56 (50.91%) out of 110 results falling in this category. The least common categories were category 2. “Enthusiastic attitudes towards the possibilities of AI in education” and category 5. “Ethical concerns about AI in education”. Complete results are displayed in Table 2.

*Table 2. The search results across all selected journals divided into predefined categories.*

| | **Category** | | | | | | |
|---|---|---|---|---|---|---|---|
| **Journal** | **1** | **2** | **3** | **4** | **5** | **6** | **7** |
| Computers & Education | 27 | 0 | 4 | 3 | 1 | 8 | 10 |
| British Journal of Educational Technology | 8 | 0 | 1 | 3 | 1 | 0 | 1 |
| Journal of Educational Technology & Society | 7 | 1 | 1 | 0 | 0 | 2 | 5 |
| Education and Information Technologies | 12 | 2 | 4 | 0 | 0 | 3 | 1 |
| Educational Technology Research and Development | 0 | 0 | 0 | 1 | 1 | 0 | 0 |
| Review of Educational Research | 0 | 0 | 0 | 0 | 0 | 1 | 0 |
| Journal of the Learning Sciences | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| Developmental Review | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| American Educational Research Journal | 0 | 0 | 0 | 0 | 0 | 0 | 0 |
| Teaching and Teacher Education | 1 | 0 | 0 | 0 | 0 | 0 | 0 |
| **Total in category** | 56 | 3 | 10 | 7 | 3 | 14 | 17 |
| **Percentage of all classified results** | 50.91% | 2.73% | 9.09% | 6.36% | 2.73% | 12.73% | 15.45% |

Table 3 displays the number of articles published per year. A bit under half (n=54, 49,09%) of the 110 articles were published in 2021. The number doubled from the previous year of 2020 (n=26, 23,64%) showing a clear increase. During the first 4 months of 2022 (n=30, 27.27%) the number is already larger than in 2020 and over half of 2021.

*Table 3. The number of articles per year.*

| Year | Number of AI-articles | Percentage of total |
|---|---|---|
| 2020 | 26 | 23.64% |
| 2021 | 54 | 49.09% |
| 2022 | 30* | 27.27% |

The prevalence of the categories from largest to smallest are listed below:

1. Case studies of adapting AI-based tools in education. (n=56, 50.91%)
2. Studies about including or using AI education in curriculum. (n=17, 15.45%)
3. Meta study or literature review. (n=14, 12.73%)
4. Critical reviews of AI in education. (n=10, 9.09%)
5. The future predictions of what AI may provide in the future for education. (n=7, 6.36%)
6. Enthusiastic attitudes towards the possibilities of AI in education. (n=3, 2.73%)
   Ethical concerns about AI in education. (n=3, 2.73%)

The two least prevalent categories are not listed in any particular order with both having 3 articles representing 2.73% of the search results.

## 4. Discussion

Perhaps unsurprisingly, case studies of adapting AI-based tools was found to be the most prominent category in this meta-study. We believe that we are only starting to scratch the surface of what is possible through the use of AI in education. Perhaps over half of the studies reviewed for this paper dealing with trying to determine the usefulness of AI from various, quite narrow perspectives, through case studies is also indicative of where the current state of the field is.

The second most prevalent category also came as no surprise, since talk about the importance of including AI education in curriculum has been increasing over the past few years. China for example is mandating AI education for their high school curriculum and the United States is also experimenting with different implementations of AI in curriculum (Peterson, et al. 2021). The role of AI will very likely keep increasing in societies around the world as the technology advances and becomes more accessible. Providing the next generation with the means to understand AI and how it affects our lives is something that we look at as a crucial step for all school systems to take in their future curricula.

The lack of articles dealing with ethical concerns about the use of AI in education was surprising, considering this is an area with lots of research and discussion around the ethical considerations of implementing AI in educational contexts from both researchers and the general public (e.g. Holmes, et al. 2021; Latham & Golts, 2019) as well as the need for AI ethics education for present and future developers of these technologies (e.g. Borenstein & Howard, 2021; Garret, et al., 2020). This could be in part due to the nature of research being done around this emerging field. We hypothesize that the researchers dealing with the technical implementations of AI-based technologies often come from a stronger technological background as opposed to a background in educational sciences. Understanding the intricacies of educational sciences could be considered essential to understanding some of the ethical concerns and implications of AI-based systems in the educational context. We hope that the future sees educational scientists working more closely together with those from more technological backgrounds to gain a more holistic understanding of the possibilities and concerns around the ever-increasing prevalence of AI in education.

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