Beyond the Boundaries of Research Fields - Mapping Educational Science in the Broader Academic Discourse about Artificial Intelligence

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Abstract

Over the past three decades, research in Artificial Intelligence (AI) has steadily grown and advanced. The recent surge in generative AI tools, such as ChatGPT, has reignited interest also among research fields that otherwise seemingly turned their focus elsewhere. More specifically, the field of Education has seen a remarkable surge in research on AI (AIEd), examining its impact on various types of learning. While these investigations offer valuable exploratory insights, many lack systematic analysis. Moreover, they overlook the potential overlap and commonalities with other research domains. This study addresses this gap by utilizing the OpenAlex database to identify and analyze not only AI-related publications since 2000. Through part-of-speech tagging and semantic network analysis, and focusing on the AIEd as our anchor, we map content relationships across the literature to reveal thematic structures and potential synergies across research fields. The findings offer an exploratory overview of the evolving research landscape, the position of AIEd therein, and suggest directions for future inquiry.

1 Introduction

There has been a growing interest in AIEd research over the past three decades, with a focus on three key areas: predictions, personalization, and assessment. In the area of prediction, AI tools play a pivotal role in learning analytics by analyzing learner profiles to predict academic achievement, dropout risks, retention rates, and even admission decisions. Numerous studies leverage these insights to enable institutions to intervene proactively, support at-risk students, and make data-driven decisions to enhance educational outcomes (Batool et al., 2023; Fahd et al., 2022). Tools such as Course Signals, Coursera, and learning management systems exemplify the use of predictive analytics, applying AI to monitor students' learning process and enhance their academic success. For personalization, AI analyzes student data to create tailored learning pathways that address individual needs and optimize outcomes. Intelligent tutoring systems, such as Carnegie Learning's Cognitive Tutor, offer personalized guidance and feedback, while adaptive learning platforms like Khan Academy and Duolingo adjust content dynamically based on student progress. These tools not only foster deeper engagement but also empower students to achieve their academic goals at their own pace (Lin et al., 2023). In assessment, AI tools have been used to automate grading and assessment tasks, allowing educators to focus on providing meaningful, targeted feedback. Tools like Turnitin's automated essay scoring system efficiently evaluate written work, saving instructor's time for personalized feedback to students (Kostka and Toncelli, 2023). Together, the AI tools applied in these three key areas primarily fall under reactive and limited memory AI. However, the rapid advancement of generative AI (GAI) tools has opened up new possibilities. Starting in 2022, there has been a surge in AIEd research, with a focus on GAI tools like ChatGPT and their transformative impact on teaching and learning.

2 Rationale of the Study

Researchers are exploring how GAI tools can be applied in various research fields, including computer science (Kar et al., 2023; Parker, 2025), health sciences (Moulaei et al., 2024; Sai et al., 2024a), engineering (Sai et al., 2024b; Vu et al., 2024), as well as business and economics (Orchard and Tasiemski, 2023; Yu and Qi, 2024). More specifically, and from the perspective of AIEd, research is largely dealing with highlighting its potential to reshape traditional educational practices.

This study builds on the considerations laid out in the previous section and investigates the position of AIEd in the broader academic discourse about AI. More specifically, we employ part-of-

speech tagging and semantic network analyses to analyze publications on AI identified in the OpenAlex database. This type of approach has been suggested to map research fields in a wider context (McAllister et al., 2022) and highlight the potential for synergies and spillovers (Hou et al., 2022). The goal is to unveil underlying structures that can be used as a point of departure for further investigations of common terminology, content topics, and interrelations between research fields. Consequently, in the context of this exploratory study, our research questions are:

RQ1) *What does the general academic landscape look like on the overarching research topic of AI?*

RQ2) *To what extent can we identify content overlaps between research fields?*

RQ3) *Where does AIEd interconnect with other research fields?*

Next, we provide an overview of our data collection procedures and two types of analysis to guide the reader.

3 Methods

3.1 Data Collection

Article metadata was extracted from OpenAlex, the first open-source, large-scale, and multilingual bibliometric database (Priem et al., 2022). Based mainly on data extracted from the discontinued Microsoft Academic Graph as well as from other bibliometric and bibliographic databases and repositories, OpenAlex has been shown to offer superior document, journal, and language coverage than existing proprietary databases (Alperin et al., 2024; Culbert et al., 2025; Jiao et al., 2023; Thelwall and Jiang, 2025). As a result, a growing number of research projects are using this database to conduct various types of bibliometric-based research, focusing on topics such as article retractions (Hauschke and Nazarovets, 2025; Ortega and Delgado-Quirós, 2024; Yiru et al., 2025), science mapping (Haunschild and Bornmann, 2024), open access publishing (Simard et al., 2025), data reuse (Krause and Mongeon, 2023), as well as quality of geographic, disciplinary, or linguistic coverage (Maddi et al., 2025; Céspedes et al., 2025).

Of particular interest and relevance here is the recently implemented article-based topic classification of articles indexed in the database (Barrett, 2024). Based on proven multilevel coarsening and refinement article classification procedure developed and used at CWTS (Eck and Waltman, 2024; Waltman and Van Eck, 2012), these topic categories are increasingly used by geographically and disciplinary diverse scientific communities for various research purposes (Arroyo-Machado and Costas, 2023; Cebrián et al., 2025; Couto and Baltazar, 2025; de Carvalho Segundo et al., 2024)

Our search terms were deliberately broad to cast a wide net in the search. Search terms included a mix of "artificial intelligence" and specific terms that are generally mentioned in literature reviews on the topic across different disciplines, including "risk", "challenges", "opportunities", "education", and "impact". While a "casting the net wide" approach also has potential drawbacks, we believe that this technique provides a valuable approach to possibly discover commonalities between disciplines (Authors, 2019). The search was conducted on the 7th of May, 2025, and was limited to publications ranging from the 1st of January 2000 until the 31st of December 2024. The 43,598 results were downloaded into a dataframe in the statistical software package R. We then filtered for publications that also included an abstract, resulting in a consolidated dataset of 27,202, which were then analyzed using the R libraries igraph, quanteda, tm, and udpipe.

3.2 Part-of-Speech Tagging

The main idea of part-of-speech tagging is to assign each word of a text to its proper syntactic tag in the context of its appearance (Chiche and Yitagesu, 2022). This is also referred to as grammatical tagging (Khan et al., 2019) and ensures grammatical relevance. Here, we used POS on the titles and abstracts of the collected publications. More specifically, we focused on nouns, verbs and adjectives. Furthermore, based on the POS results, we then determined n-grams to capture meaningful co-occurrence patterns (Bai et al., 2021; Ojo et al., 2021). This complementary approach allowed us to identify key concepts and their contextual relationships from both titles and abstracts.

3.3 Semantic Network Analysis

Semantic network analysis (SemNA)is a technique used to identify and visualize relationships between key concepts based on their co-occurrence within textual data (Castelblanco et al., 2021; Segev, 2022). In the context of this study, key concepts were determined by the classification procedure

employed by OpenAlex. We specifically focused on the category of "subfield", as it allowed us to take a more granular approach to looking at the data. The textual data was taken from the preceding POS analyses and determined n-grams. Here, we applied SemNA to both titles and abstracts of the collected publications. Titles offered a high-level overview of thematic structures, while abstracts allowed for a deeper exploration of concept relationships. The resulting networks then provide a more nuanced understanding of the topical landscape and its underlying structures.

4 Results

4.1 Descriptive Analysis

Tables 1 and 2 provide a glimpse at the underlying data for the categories fields and subfields.

Table 1: Top Research Fields (based on N publications in our data set)

Field	N
Computer Science	16687
Medicine	7819
Social Sciences	5753
Engineering	3226
Business, Management & Accounting	2525

Table 2: Top Research Subfields (based on N publications in our data set)

Subfield	N
Artificial Intelligence	8463
Health Informatics	4293
Computer Science Applications	3449
Safety Research	3011
Information Systems	2422
Management Information Systems	1351
Radiology, Nuclear Medicine & Imaging	1250
Management Science & Operations Research	948
Education	823

4.2 POS, n-grams & SemNA

Starting with the investigation of titles, and focusing on the subfields indicated in Table 2, we determined the semantic network visualized in Figure 1.

Here, we see that there is considerable content overlap between the different research subfields. More specifically, irrespective of the underlying discipline, scholars were largely concerned with "explainable AI", "risk management", "challenges", and "case studies". Focusing on AIEd, Figure 2 underlines these findings, while clearly showing that the perspective on these topics has been from an educational perspective, e.g. concentrating on the context of higher education and generative tools. The later suggests an inerest and discourse about how

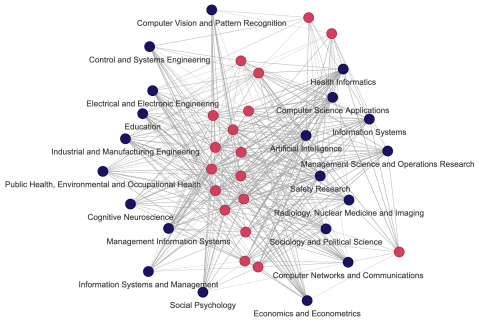

Figure 1: Semantic Network for Subfields (Titles)

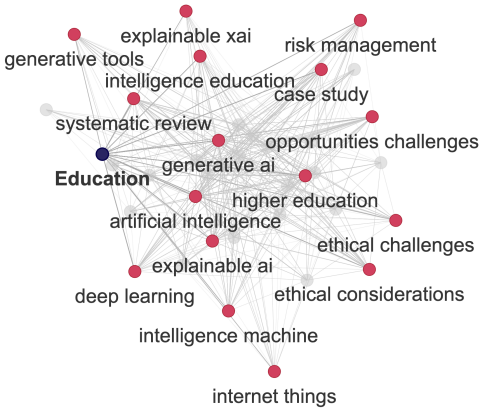

Figure 2: Semantic Network for AIEd (Titles)

We then turned to the abstracts, in order to engage into a deeper exploration of concept relationship. Figure 3 provides the overall view, while Figure 4 highlights AIEd again. Here, we found that the core of the semantic network is largely driven by the subfields of "artificial intelligence", "information systems", "management science", and "industrial and manufacturing engineering". Another closer look at AIEd (Figure 4) then revealed that scholars seem particularly interested in AI for "language education", "student engagement", and "prompt engineering". Moreover, a sizeable amount of publications were also concerned with "compliance" and "risk management".

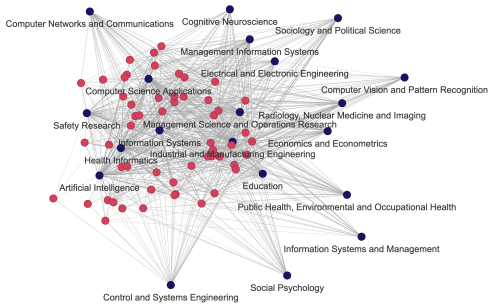

Figure 3: Semantic Network for Subfields (Abstracts)

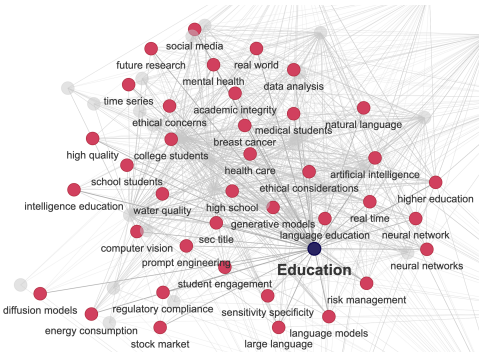

Figure 4: Semantic Network for AIEd (Abstracts)

5 Discussion

This study set out to map AIEd in the broader academic discourse about AI and identify possible synergies and spillovers across research fields. Our results indicate that while AIEd has certainly experienced a surge in publications, other traditionally more technical and computational domains remain at the core of the research field at this point in time (RQ1). However, using POS, n-grams and semantic networks, we have also been able to show considerable interconnections between the different fields (RQ2). This supports the general trend of more interdisciplinary research and the specific request to address the topic of AI from different, interrelated perspectives (Følstad et al., 2021; Newman, 2024). Finally, concentrating on AIEd, we have been able to identify promising "low-hanging fruits" of content overlaps with different research fields that can provide mutual benefit for AIEd and related fields (RQ3). More specifically, while AIEd can benefit from groundwork and various applications on the topic of e.g. "prompt engineering", other fields could use AIEd as a type of proving ground to test and validate the findings from their own fields. While this study provides valuable insights into where AIEd is located in the larger context of research on AI, it is also subject to some limitations that should be considered when interpreting the results and designing future studies on the topic. First, we built our literature search on topics and concepts informed by discourses within the research field of education. Future research, also based on or findings should consider casting the web even wider, in order to potentially collect a more holistic sample of the underlying academic discourse. Second, the focus of our work has been on titles and abstracts, rather than full papers. While this is a good point of departure, it bases the analyses on limited amount of text. Next possible steps could include the analyses of entire publications, to provide an even more nuanced view, providing even better chances to identify possible overlaps and synergies.

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