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MAPPING TRENDS IN ARTIFICIAL INTELLIGENCE AND EDUCATIONAL ASSESSMENT

The digital era transformed education, offering promising development opportunities. However, despite having a significant amount of data, education still lacks specific mechanisms for using it to improve learning, teaching and decision-making. There is a growing body of research advocating for application of AI in education. Advantages of AI come with its ethical concerns related to bias, transparency and privacy. At the same time AI-based assessment is still underexplored in literature. In addition, emerging research trends, links between AI and assessment and existing research communities remain largely unexamined. The paper aims to explore the evolving research patterns, link between AI and educational assessment and existing research communities.

This study adopts a bibliometric methodology to analyze the research literature on AI and assessment. Thus, metadata was collected from the Web of Science by Clarivate and Scopus databases over a span of almost 15 years. The obtained data was cleaned, standardized, and combined, resulting in a corpus of 1,465 publications. VOSviewer was used to visualize thematic clusters, author networks, and key areas reflecting current trends in AI in educational assessment. The bibliometric analysis reveals the growing use of machine learning, learning analytics, and intelligent mentoring systems to personalize the educational process and support academic success in modern research.

Keywords: Artificial intelligence, education, assessment, bibliometric analysis, machine learning.

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Жасанды интеллект және білім беру бағалауы саласындағы тенденцияларды талдау

Цифрлық ғасыр білім берудегң елеулі өзгерістер мен жаңа мүмкіндіктерге жол ашты. Дегенмен қолжетімді деректердің байлығына қарамастан, білім беруде әлі де оқуды, оқытуды және шешім қабылдауды жақсартуда пайдаланудың нақты механизмдері жоқ (OECD, 2023). Білім беруде жасанды интеллектті пайдалану жөніндегі зерттеулер өскен сайын, біржақтылық, ашықтық және құпиялылық мәселелері өзекті бола түсуде. Дегенмен, бағалауда AI қолдану әдебиеттерде аз зерттелген. Сонымен қатар AI мен бағалау арасындағы байланыс осы саладағы бар зерттеу қауымдастықтарымен де зерттелмеген. Бұл жұмыстың мақсаты дамып келе жатқан зерттеу үлгілерін, AI мен бағалау арасындағы байланыстарды және осы саладағы бар зерттеу қауымдастықтарын шолу болып табылады. Зерттеу AI және бағалау бойынша зерттеу әдебиетін зерттеу үшін библиометриялық талдауды пайдаланады. Метадеректер соңғы 15 жылда Web of Science және Scopus дерекқорларынан жиналды. Алынған деректер тазартылды, стандартталды және біріктірілді, нәтижесінде 1465 жарияланым жинақталды. VOSviewer тақырыптық кластерлерді, авторлық желілерді және білім беруді бағалаудағы AI-дағы ағымдағы үрдістерді көрсететін негізгі аймақтарды визуализациялау үшін пайдаланылды. Библиометриялық талдау оқу үдерісін жекелендіру және заманауи зерттеулерде академиялық жетістіктерді қолдау үшін машиналық оқытуды, оқу аналитикасын және интеллектуалды тәлімгерлік жүйелерін пайдаланудың артып келе жатқанын көрсетеді.

Түйін сөздер: жасанды интеллект, білім беру, бағалау, библиометриялық талдау, машиналық оқыту.

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Анализ тенденций развития искусственного интеллекта в образовательном оценивании

Цифровая эпоха способствовала значительным изменениям и созданию новых возможностей в образовании. Однако, обладая значительным массивом данных, образование всё ещё не имеет конкретных механизмов использования его для совершенствования обучения, преподавания и принятия решений. С ростом числа исследований в области применения ИИ в образовании всё острее встают вопросы предвзятости, прозрачности и конфиденциальности. При этом применение ИИ в оценивании остаётся мало изученным в литературе. Помимо этого, связь между ИИ и оценкой, а также существующие исследовательские сообщества в данной области остаются в значительной степени неизученными. Целью статьи было рассмотреть развивающиеся исследовательские паттерны, связи между ИИ и оценкой, а также существующие исследовательские сообщества в данной области. В исследовании используется библиометрический анализ для изучения исследовательской литературы по ИИ и оценке. Метаданные были собраны с баз данных Web of Science и Scopus за последние 15 лет. Полученные данные были очищены, стандартизированы и объединены, что позволило сформировать корпус из 1465 публикаций. С помощью VOSviewer были визуализированы тематические кластеры, авторские сети и ключевые направления, отражающие современные тренды в области ИИ в образовательной оценке. Результаты библиометрического анализа показывают рост применения машинного обучения, аналитики обучения и интеллектуальных систем наставничества для персонализации образовательного процесса и поддержки академического успеха в современных исследованиях.

Ключевые слова: искусственный интеллект, образование, оценка, библиометрический анализ, машинное обучение.

Introduction

The digital era transformed education, offering promising opportunities for development. While education historically has always had a wealth of data, the way in which the data is applied to enhance learning, teaching, and decision making still emerges. Given the rapid development of technologies, prominently artificial intelligence (AI) and smart technologies, their role in education is becoming more influential (OECD, 2023). There is a growing body of publications advocating for AI application in education (Archibald et al., 2023; Baker, 2020). AI has the potential to revolutionize education through personalized, intelligent learning, management, and immersive educational experiences. However, these potential prospects come with ethical concerns related to bias, transparency and privacy of AI application in educational context (Ifenthaler, Majumdar & Gorissen, 2024). At the same time AI-based assessment is still underexplored in literature. There is no research on emerging research trends, link between AI and assessment and existing research communities. Thus, the focus of the paper aimed at exploring the evolving research patterns, mapping link between AI and assessment and existing research communities in AI and educational assessment.

The following research questions are considered in the paper:

- What are the research trends, emerging themes on connection between AI in educational assessment?
- What are the main cooperation patterns and research communities in connection between AI in educational assessment explored in co-authorship networks?

By considering these questions, the paper aims to contribute to shedding the light on the connection between AI and educational assessment and its implications for future inquiring and practice. The importance of this study lies in its potential to discuss the changing role of AI in educational assessment among educators, policy makers and scholars. The paper contributes to the establishment of emerging trends related to AI application in education by identifying areas that would benefit from deeper exploration.

Literature review

There is a growing body of research exploring integration of AI in educational context (Ifenthaler, Majumdar & Gorissen,2024), particularly on its transforming effect on teaching and learning in

secondary and higher education (Alhazmi & et al., 2024; Fu, Weng & Wang, 2024). AI individualizes learning experience, teaching, and fosters collaborative learning (Lokare & Jadhav, 2024; Retscher, 2024). At university level, research suggests that AI enhances academic performance, motivation, and critical thinking, however it shows no significant effect on self-efficacy (Ma, Ismail & Han, 2024). It is used to predict student success and enhance student assessment (Alyahyan & Düştegör, 2020; Sano & et al., 2024). Nevertheless, application of AI in education may cause significant issues related to ethical concerns of data privacy and diminished critical thinking due to over-reliance on AI. Its effectiveness depends on investment in infrastructure and continuous professional development of educators. AI adoption requires a commitment to equity, transparency, and academic integrity to ensure meaningful educational outcomes (Mao,Chen & Liu, 2024; Retscher, 2024). Along with investigation of long-term effects of AI, prioritization of objective measures of higher-order thinking, the refinement of assessment is required (Ma, Ismail & Han, 2024). The existing literature has largely overlooked the AI application in educational assessment. Moreover there is a lack of bibliometric research on AI and assessment in education, considering core research trends, emerging themes on connection between AI in educational assessment as the main cooperation patterns and research communities in connection between AI in educational assessment.

Current Kazakhstani research address this gap by considering AI in adaptive learning, teacher training, assessment and digitalization (Tukumov, 2024; Bekmanova et.al, 2025; Kazimova & Adekenova, 2025; Malikova et.al., 2025; Myrzabek et.al., 2025).

Educational institutions apply AI-based tools in improving educational assessment although academic excellence is overlooked. Studies suggest that ethical methodology promoting active, inclusive assessment methods should be considered. Adding factors such as motivation and attitude, affecting the assessment, ensure accuracy (Borna, Saadat, Hojjati, & Akbari, 2024). Kılınç (2024) offers a practical framework of ethical AI application in assessment. Others emphasize pedagogical methods and ethical issues. There are studies based on bibliometric or systematic reviews on AI and education, however only a few of them focus on AI and assessment (Taskin Bedizel, 2023; Radu, Ciocoiu, Veith, & Dobrea, 2024; Uysal, Topal, & Demir Kaymak, 2024). They revealed papers on student assessment. AI supports education tremendously, particularly for tutoring, assessment and personalization of education. Authors conclude that the collaboration between educators and AI experts must be enabled. Technology and education should be incorporated to enhance technology's application in education (González-Calatayud, Prendes-Espinosa, & Roig-Vila, 2021).

To make sure that AI improves the assessment of academic achievements the area must be developed beyond isolated research toward collaborative, data-informed studies. Bibliometric analysis not only enables a retrospective view but also promotes a strategic instrument in shaping application of AI in educational assessment .

Research methods

Methodology. Data and methods

The study adopts a bibliometric methodology to analyze the literature on AI and assessment. The dataset creation approach employed in the study aimed to compile a broad and inclusive corpus of literature on AI and assessment. Thus, metadata was collected from the Web of Science (WoS) by Clarivate and Scopus databases over a span of almost 15 years. Scopus and WoS are among the most widely utilized collections of scholarly publications for bibliometric and scientometric research (Martin & Martin, et.al., 2021). WoS indexes more than 22,209 journals across science, social sciences, humanities, and the arts, containing over 74 million records and 2.23 billion cited references dating back to the 1900s (Clarivate Analytics, 2025). The Scopus database contains up to 97.3 million documents, 94,000 institution profiles and 2,4 billion cited references dating back to 1970 (Elsevier, 2025).

Dataset creation

The data was collected in the second week of March 2025. The study utilized three citation indexes in the WoS database: the Science Citation Index Expanded, the Social Sciences Citation Index, and the Arts and Humanities Citation Index. The search used a Boolean query including following keywords: artificial intelligence, AI, educational assessment, assessment in education, student evaluation, academic performance, student success, formative assessment, summative assessment, relation, effect, impact, influence, connection, link, role, association, causality and correlation. These terms were combined using logical operators to refine the search and ensure comprehensive coverage of relevant literature.

The query was designed with logical operators (OR, AND) to ensure inclusivity while maintaining specificity, and wildcard symbols (*), allowing for the inclusion of variations. The search was applied to titles, abstracts, and keywords to maximize relevance and precision. This approach ensured a systematic and thorough retrieval of studies that address creativity and its impact on academic achievement within educational settings.

Data collection

WoS

The initial search returned to a total of 957 publications. These documents were filtered through the following steps. Publications were not limited to the research categories and document type. Only documents in English were retained to ensure consistency in analysis, resulting in a dataset of 942 documents. The data search resulted in the 2010 to 2025 period. This resulted in 936 documents. Quick filters were not applied. For each of the 936 retained documents, bibliometric metadata was extracted, including: year of publication, number of authors, institution/affiliation, country, journal, cited references. Further, "title", "abstract", and "keywords" were extracted for analysis.

Scopus

The initial search returned to a total of 809 publications. These documents were filtered through the following steps. Publications from 2010 to 2025 were included. This resulted in a total of 792 documents. Publications were not limited to the subject area, document type and keywords. Only documents in English were retained to ensure consistency in the analysis, resulting in a final dataset of 779 documents. For each of the 779 retained documents, bibliometric metadata was extracted, including: year of publication, number of authors, institution/affiliation, country, journal, cited references. Additionally, "title", "abstract", and "keywords" were extracted for analysis. The data exported from WoS (779) and Scopus (936) databases were cleaned, duplicates were merged via Zotero software and exported in CSV and RIS files which resulted in 1465 documents. The data was carefully reviewed to identify any issues, such as missing information, duplicate entries, and inconsistencies. Duplicates were eliminated by checking the DOI and Title, while missing values in key fields were filled or removed. To ensure consistency, column names were standardized, and text formatting was adjusted. The Publication Year and Citation Count were checked for accuracy. Once unnecessary columns were removed, the cleaned dataset was saved in CSV format, ready for analysis, with the cleaning process carried out using R (Wickham & Henry, 2020).

Study Limitations

The choice of the WoS and Scopus databases was driven by their extensive coverage and reputation as two most influential journal citation indexes, widely used for bibliometric and research evaluations (Asubiaro et al., 2024). However, no bibliometric review can provide a complete and flawless representation of a field or discipline. Consequently, some relevant literature from non-indexed, non-English journals may have been excluded. The limitations of these databases concern their underrepresentation of journals in social sciences and humanities, as well as for biases favoring English-language publications and the life sciences (Asubiaro et al., 2024). WoS and Scopus primarily index peer-reviewed journal articles, excluding books, monographs, conference proceedings, and grey literature. Their strict inclusion criteria often exclude newer or regional journals. Citation metrics favor disciplines with higher citation rates, and indexing delays can affect recent publications. Additionally, inconsistencies in author and institutional data and issues like self-citations can impact results (Echchakoui, 2020).

Analysis Tools

The extracted data was analyzed using bibliometric tools such as VOSviewer to visualize networks of co-authorship, keyword co-occurrence, and citation relationships. These tools allowed us to identify research trends, emerging themes, thematic clusters within the field of educational research and authorship network, communities on connection between AI in educational assessment (Perianes-Rodriguez, Waltman & Van Eck, 2016). To visualize bibliometric networks in the form of network maps Vosviewer uses various metrics. The maps illustrate authors and publications as nodes. Each node is assigned to one cluster in a network and each cluster is a complex of nodes closely connected based on particular metrics.

Results and discussion

RQ 1: "What are the research trends, emerging themes on connection between AI in educational assessment?

Network Structure and Key Themes

The network graph illustrates (Figure 1) the interrelations that exist among various concepts of AI in education. Each vertex on the graph represents a term, while the edges show the interrelations among the constituents. Each color represents different themes, while the magnitude of each dot represents the concept's importance. Understanding these interconnections helps in identifying patterns and new directions in education in the context of AI. The co-occurrence analysis via VOSviewer of data revealed the following clusters, representing emerging research trends in educational research on AI and assessment in educational settings (Perianes-Rodriguez, Waltman & Van Eck, 2016).

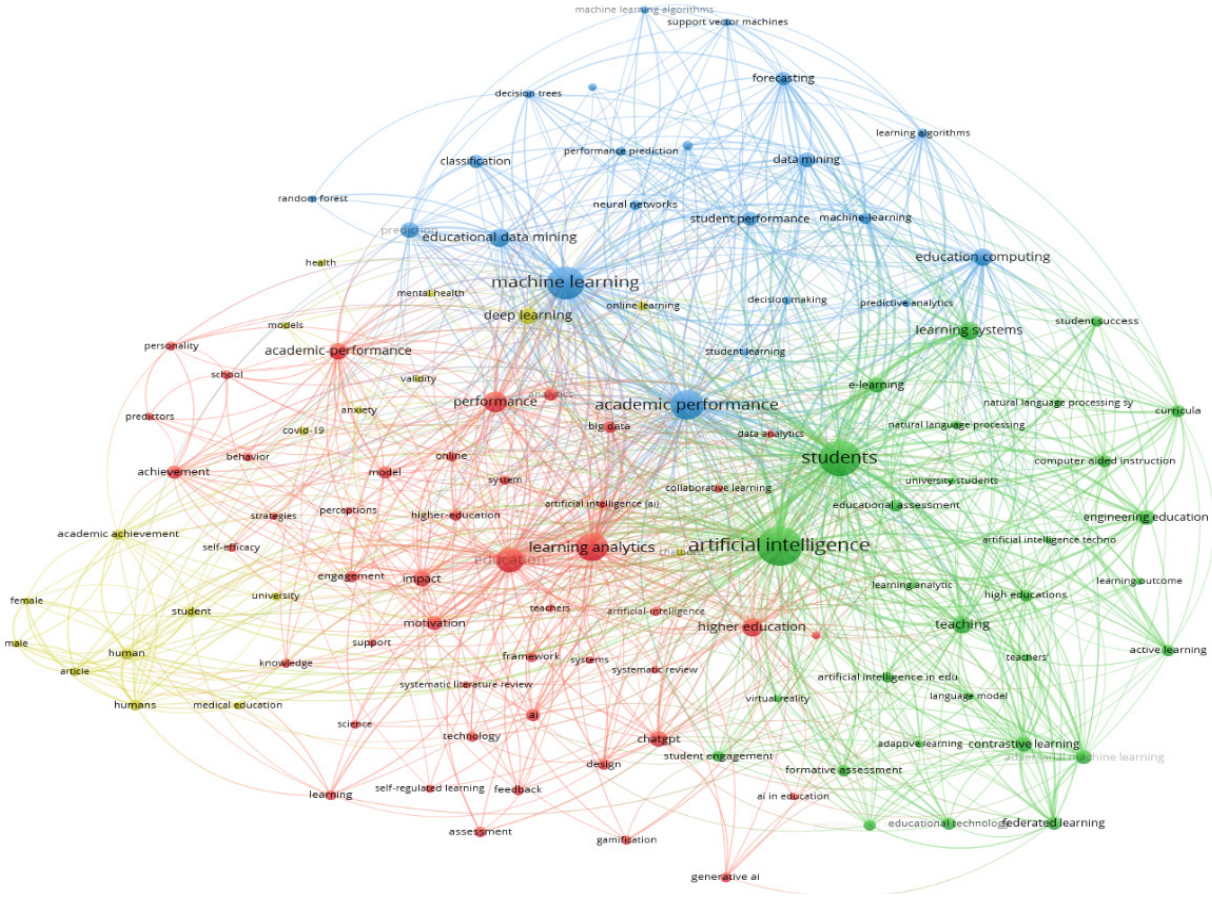

Figure 1 – Co-occurrences of keywords, 1465 papers published in Web of Science and Scopus 2010–2025 (Source: Data extraction from Vosviewer).

Machine Learning and educational assessment (blue)

The application of machine learning results improved insights, learning outcomes and transformed the education sector. Machine learning may be an effective instrument of assessment at educational institutions. Advanced technologies like deep learning, decision trees, and neural network systems for data processing and analysis enable educators to take Early Responsive Action (ERA) to assist students who may be struggling. AI in education supports teachers in making evidence-based decisions. Out of a massive amount of data it predicts outliers: underperformers and students with high potential (Desarkar, Das, & Chaudhuri, 2022; Guanin-Fajardo, Guaña-Moya, & Casillas, 2024; Owusu-Boadu et al., 2021; Verma, Yadav, & Kholiya, 2022). Some authors suggest innovative models of academic achievement prediction. Desarkar, Das, & Chaudhuri (2022) propose an interactive assessment system based on models applying AI approaches: decision tree induction, character trait classification

and text analytic tools. The system promotes assessment as well as persistent support in gaining the goal. It uncovers the following 5 types of outliers: positive outliers, the capable-of-mentoring class, the self mentoring class, the needs-mentoring class, and the negative outliers requiring special attention.

Learning Analytics and Student Performance (red)

AI-powered learning analytics gleans pertinent information regarding student participation, motivation, and performance (Gašević, Siemens, & Sadiq, 2023; Sun et al., 2021; Sharma et al., 2020; Al-Shabandar et al., 2018). AI can analyze self-regulated learning activities and provide feedback in real time while studying student interactions with instructional material (Bannert et al., 2017; Rakovic et al., 2024; de Araujo et al., 2024). The growth of adaptive learning technologies indicates the shift towards personalized education, supported by AI that adjusts teaching material to fit the learner's needs and pace (Topali et al., 2025; Alalawi et al., 2024; Converse et al., 2019; Converse, Curi, & Oliveira, 2019).

AI in Teaching and Learning Systems (green)

The impact of AI in teaching goes beyond assistive technologies, as it improves instruction delivery and teaching materials (Storey & Wagner, 2024; Ivanova et al., 2024). Adaptive systems, natural language processing, and auto grading have created improved learning environments that are more engaging and interactive(Afzaal et al., 2021; Salas-Pilco et al., 2022; Ahmad et al., 2024). Personalized instruction is provided by intelligent tutoring systems, which decentralize AI processing for security and privacy purposes (Ahmad et al., 2024; Liu et al., 2025). These changes enable more engaging and learner-centered education (Gligorea et al., 2023; Demartini et al., 2024).

Human Learning and Psychological Factors (yellow)

AI applications in education, particularly in medical education demonstrate how technology can complement human learning without replacing essential cognitive and emotional aspects (Alessi et al., 2024; Liu et al., 2025; Ahmad et al., 2024). While machine learning and analytics offer powerful solutions to enhancing students' results, human elements are still essential (Afzaal et al., 2021; Demartini et al., 2024; Al-Emran et al., 2025). As AI powered learning grows, education as a process should ensure that technology does not outweigh students' needs to reap the most from such innovations (Storey & Wagner, 2024; Cukurova, 2024).

RQ2: "What are the main cooperation patterns and research communities in connection between AI in educational assessment explored in co-authorship networks?"

To get a better understanding of the research environment and collaborative activities in the field of artificial intelligence for education, a co-authorship network analysis was conducted (Figure 2). This mapping of bibliometrics depicts author-author relationships and publication venues, leading authors, collaboration groups, and the location of central organizations such as Institute of Electrical and Electronics Engineers (IEEE) and Association for Computing Machinery (ACM). The research also uncovers the interdisciplinary and dynamic nature of the field through collaborative practices.

Structure of the Network

The visual representation of the network consists of edges and nodes, with each node representing a researcher or a location where publications are published (e.g., a conference or journal), and each edge representing a co-authorship relationship. The size of the node is proportional to the number of contributions–either in the form of publication output or citation impact–while different clusters or communities of researchers who co-author regularly are represented by colors.

Central Nodes and Hubs

The most influential node in the graph is IEEE, situated at the center of the map with extensive relationships with various clusters. Its central location indicates that IEEE is the prime publication destination for interdisciplinary research on AI and education. Similarly, ACM and the Association for Computing Machinery are shown to be influential hubs, especially in technology-oriented subdomains such as educational data mining and learning analytics.

Among solo researchers, Dragan Gašević is extremely influential. His node is centrally located and large, and he serves as a central bridge between multiple clusters. Gašević's work in learning analytics has had both pedagogical and technical influence, so his work is a hub for many subfields. Other central researchers include Hussain, A., at the center of an extremely well-connected cluster aligned with IEEE, and Baraniuk, R.G., very strongly linked with ACM-related work.

Clustering and Thematic Communities

The graph illustrates several well-defined clusters, each indicating a thematic or institutional research group:

Red Cluster: Gašević, D., Li, H., and Li, L. form the core of this cluster, which is closest to the Association for Computing Machinery and focuses on learning analytics, educational technology, and data-driven decision making in education.

Blue Cluster: Baraniuk, R.G., Di Mitri, D., and Drachsler, H. form the community that is focusing on intelligent tutoring systems, digital learning environments, and computer science education.

Green Cluster: Includes researchers such as Saqr, M., Pripto, L.P., and Akçapınar, G. This cluster is likely engaged in multimodal learning analytics and classroom assessment technologies in real-time.

Purple Cluster: Around Hussain, A. and connected to several small nodes, this cluster signifies a broad interdisciplinary network, discussing topics such as machine learning in education, AI-based learner modeling, and ubiquitous computing.

Cyan and Yellow Clusters: These clusters have notable authors such as Khosravi, H., Joksimovic, S., and Ifenthaler, D., reflecting the focus on predictive analytics, AI-based feedback systems, and the ethics of educational technology.

Bridge Authors and Interdisciplinary Links

Certain authors, such as Chen, XL and Joksimovic, S., are bridge nodes, connecting fragmented clusters. Such authors write both in technically focused venues (e.g., IEEE) and in pedagogically focused ones, reflecting the interdisciplinarity demanded by AI in education research. Cross-cluster connections reflect thematic intersections as well as cooperative efforts beyond traditional disciplinary spaces.

Implications for the Field

This network analysis of co-authorship clearly illustrates a well-connected and cooperative field, where core publication avenues and leading scholars are the conduits of disseminating knowledge. The predominance of leading institutions like IEEE and ACM signifies the technical foundation of the field, whereas learning analytics and educational data mining communities reveal growing emphasis on evidence-based teaching design. In addition, the fact that there are several closely connected clusters indicates good levels of specialization, as well as the visibility of bridge authors indicating continued interdisciplinary integration. As AI further transforms the landscape of education, these collaborative configurations will change, giving rise to new avenues of research and methodology.

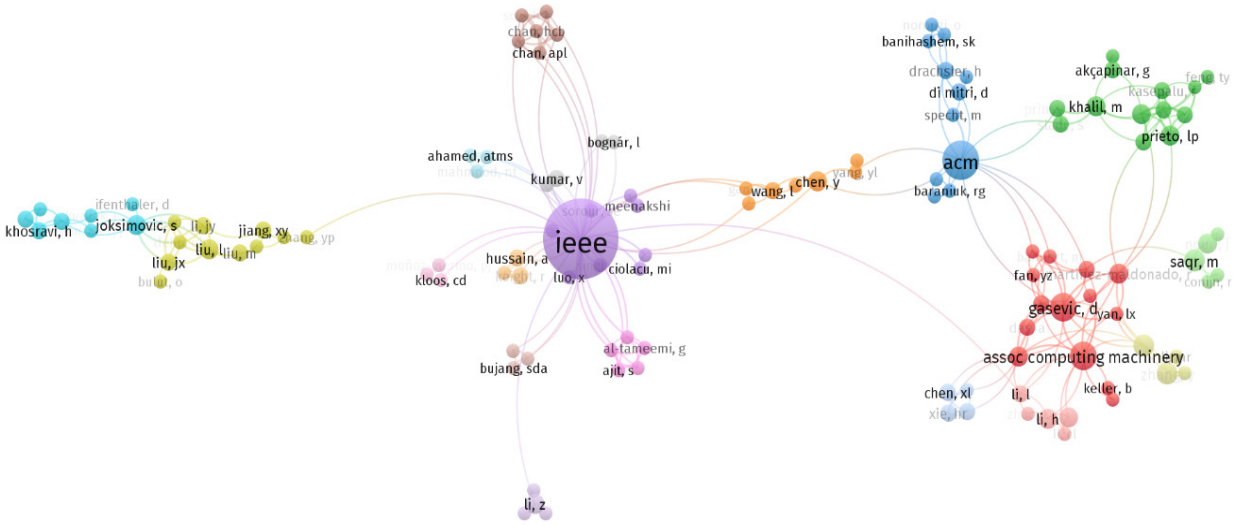

Figure 2 – Co-authorship Network in the Field of AI and assessment in education (Source: Data extraction from Vosviewer).

Conclusion

AI in education and assessment literature details trends such as increasing application of machine learning, learning analytics, and intelligent tutoring systems to provide personalized learning and support student success. The next technologies allow for real time feedback, adaptive learning and data-driven decisions, but also place importance on balancing human elements like motivation and self-efficacy. Interdisciplinary scholarship around this is extensive with centres such as IEEE and ACM publication venues, and leading authors such as Gašević, D. Network structural co-authorship analysis yields clustered, close-knit groups of work, centered around topical research areas, such as intelligent systems, education data mining, or AI ethics. Pedagogy and technology silos get bridged with bridge authors acting as an open-integrated actively evolving community.

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