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Artificial Intelligence in Generation Z Education: Mapping Current Research Trends

Introduction - Generation Z's Interaction with Digital Technologies in the Context of Education

Generation Z students, also known as digital natives, are currently studying in secondary schools and universities, largely replacing the older generation of so-called millennials. This population differs in various characteristics from previous generations and has therefore attracted academic interest in recent years, particularly in efforts to identify effective ways of teaching this cohort (Nichols & Wright, 2018). Members of Generation Z are generally defined as those born between 1995 and 2010, although this timeframe may vary slightly depending on the source. Digital natives have never known a world without information and communication technologies, and because these technologies have always been readily available to them, they have been connected to digital media from an early age (EIM Editorial Team, 2024). With constant access to information and the availability of modern technologies, Generation Z has developed learning preferences that differ from those of previous generations. They tend to prefer visual and interactive learning

and expect engaging, personalized instruction (Seemiller & Grace, 2017). Moreover, modern technology allows Generation Z to be autonomous and self-paced in their learning (Chan & Lee, 2023). Students from this cohort naturally expect their formal education to incorporate modern technologies while simultaneously preparing them for the real world – that is, to gain practical experience they can later apply, for example, in the workplace. Arkhipova et al. (2019), in a study on the role and impact of information and communication technologies (ICT) on the new generation of learners, demonstrated that the use of technology in the learning process is perceived positively by students. The questionnaire survey, conducted with first- and second-grade primary school students, and also with secondary school students, i.e., members of Generation Z, revealed that the use of ICT is perceived with clear interest and positive emotions. According to the respondents, ICT makes learning more attractive, enhances the emotional dimension of learning activities, develops creative skills, and can also serve as a means of increasing motivation. In another study that explored the intentions of respondents regarding digital learning, it was found that young people do not use digital technologies solely within formal education. The survey revealed that 34% of the respondents actively engage in digital learning outside formal education; for 23.33% of them, digital learning serves as a primary resource within formal education, while 15.33% use it as a supplementary tool alongside their schooling (Persada et al., 2019).

The educational process of this generational cohort should prioritize current trends in digital learning, that is, the use of various technologies and digital tools to support the learning process (Persada et al., 2019). For the effective use of technological and digital tools in formal education, it is necessary to understand students' needs, which will enable educational institutions to implement these tools successfully (Miliou & Angeli, 2021). In this context, however, it is also necessary to emphasize that technological preferences in students' formal education are not exclusive, as suggested by some research findings. For example, a study investigating the effectiveness of traditional and digital teaching and learning methods, as well as students' perceptions of them, revealed that respondents preferred a combination of the use of digital media and print materials in teaching. The data, collected through a questionnaire survey of college students, also indicated that students consider visual tools – such as pictures, videos, or even class discussions – to be effective in the learning process. One of the more surprising findings of the study was that the third most effective method, according to students, was listening to the teacher's explanations. This approach was considered effective by 65.2% of the students, while the proportion of those who found it ineffective was the smallest among all the evaluated items. These

findings demonstrate that the teacher's role in the Generation Z classroom is still relevant (Karasova & Uherkova, 2023).

Similar findings were reported in an earlier study conducted on a sample of university students. The aim was to explore the digital learning habits of early members of Generation Z. The analysis revealed that these students still prefer traditional forms of learning combined with e-learning (Tick, 2018). Learners also tend to perceive learning resources differently, whether these are printed materials or digital media, in the context of how they process information and the relative ease of learning from these resources. The effort expended directly impacts both the amount of information retained and the depth of understanding achieved by students (Cabero-Almenara et al., 2022; Dunlosky et al., 2020). Members of Generation Z expect modern technologies to be incorporated into their education. Therefore, understanding the various differences, preferences, and needs of this generational cohort is essential for effectively integrating such technologies into the learning environment, especially in the context of the growing trend toward the use of artificial intelligence in education. The use of artificial intelligence has made its way into various disciplines and areas of everyday life. Thus, the implementation of AI in educational institutions should not be overlooked, as these technologies are now not only used for teaching but have become an important part of the system for the development and sustainability of societies (Aldosari, 2020). According to Taufiq Hail et al. (2024), the integration of technology into education has revolutionized the paradigms of both teaching and learning, with cloud applications and artificial intelligence in particular being fundamental in this transformation. AI has the potential to significantly enrich the learning environment, enhance the effectiveness of learning, and increase student interest and enthusiasm. In a study focusing on the impact of generative AI on the education of Generation Z, Zábajník & Hromada (2024) highlight various benefits and challenges in this area. Artificial intelligence has the potential to increase student engagement and motivation through personalized content and to develop analytical skills in an information-saturated environment. On the other hand, it should be mentioned that students may also become overly reliant on such technologies, which could negatively affect their ability to solve problems independently. Finally, in the context of educating Generation Z through AI, the ethical aspect is also important, which will be discussed below.

Opportunities and Challenges of Using Artificial Intelligence in Education

With the advent of modern technology, the world around us has begun to change in fundamental ways. Artificial Intelligence (AI) and various AI-based applications have been developed to make human life easier and contribute to the progress of society. This new technology has also brought new opportunities and solutions to the field of education (Pedró et al., 2019). Artificial intelligence can greatly help students in learning and also assist teachers in the teaching process. AI has the potential to effectively automate the tracking of student progress, identify areas where teacher support is needed, and recognize gaps in learning. It can help teachers streamline teaching methods and perform routine tasks such as generating assessments, grading, providing feedback, and identifying which pedagogical practices are more effective (Chaudhry & Kazim, 2021). AI can also automate activities such as grading and assessment, or other narrowly defined, often repetitive activities within higher education. AI-based systems can help identify student needs and gaps in the educational process, bring opportunities for the personalization of learning platforms, additional support for students, and change the way students search for and interact with information (Ryzheva et al., 2024; Aldosari, 2020). AI provides both teachers and students with a range of tools that can streamline the education process, some of which are becoming increasingly common in educational institutions. AI-based tools that have significant potential in the education process include personalized learning, automated assessment, chatbots, predictive models, intelligent robots, and virtual reality, according to Annush (2024), whose study summarizes the appropriate use of AI within education. Many universities have begun to incorporate these AI tools into their teaching practices, but the degree of adaptation varies across countries and institutions (Rahiman & Kodikal, 2024). According to Ryzheva et al. (2024), new approaches to the digital transformation of higher education institutions are needed – approaches that bring together all the processes of creating and using software and information tools to build digital universities.

It has already been suggested in the introduction of the study that the implementation of AI in Generation Z education brings with it various benefits and challenges. One of the problematic factors for the use of AI in the formal education of Generation Z is the ethical aspect, which has been pointed out by many academics. Williams (2024) highlighted the ethical implications of the use of chatbots in higher education. In particular, he described issues such as privacy, algorithmic bias, student autonomy in learning, and plagiarism. In this context, there is a strong call for preserving the originality of student work, maintaining academic integrity, and developing strategies that

discourage plagiarism (Perez-Alvarez et al., 2024). Regarding student perceptions of the ethical aspects of using AI in higher education, the results of a study by Medina-Guala & Parejoa (2024) showed that students' perceptions of teachers' concerns, non-reflective use of AI, and authorities' concerns were the most prominent. The results of the questionnaire survey further indicated that students perceived a need for more attention and development in AI integration among teachers. Within education, it is also crucial to be mindful of the potential harm that could arise from inaccurate pedagogical diagnoses and the prediction of student outcomes, which could impact their future development. There are also potential negative consequences resulting from educational decisions made by teachers, families, or legislators based on AI. Moreover, the impact on student development and maturity must be considered in relation to changes in the roles between teachers and students and in the pedagogical methods on which AI systems are designed (Alonso-Rodríguez, 2024). Williams (2024, p. 06) noted, in relation to the use of AI in education, that "as with other transformative technologies, the use of AI must strike a reasonable balance between benefits and drawbacks".

Methodology

The empirical investigation of the problem aims to identify trends in research on the education of a generational cohort of digital natives through the use of artificial intelligence. The research problem has been defined as follows: What trends and tendencies in research on the education of Generation Z through artificial intelligence can be identified through bibliometric analysis?

- RQ1: What thematic areas were revealed by the co-occurrence maps of keywords and terms in AI research on Generation Z education?
- RQ2: Which AI tools were identified in the co-occurrence maps of keywords and terms within the research topic areas?
- RQ3: How has the research on the selected topic evolved over time in the context of the growing number of publications?

The applied methodological procedure involved bibliometric research, in which the method of scientific mapping was employed. In its implementation, we drew on Ondrisova's (2011) study, which states that the term "bibliometrics" refers to a scientific discipline concerned with quantitative factors in the production, dissemination, and use of data. It examines the bibliographic records of scholarly publications, including document titles, authors' names, years of publication, abstracts, and keywords. It should also be noted that these documents are linked to each other through bibliographic references, which allow researchers to trace the development of different scientific fields, assess the impact of publications from one scientific field on another, and

identify which documents have been cited the most and by which authors. Bibliometric analysis is considered a key tool among academics because it provides researchers with the ability to track how the intellectual, social, and conceptual structure of any scientific field has evolved over time. The methodological procedure consisted of two phases: data collection and subsequent analysis and visualization. The data collection itself was developed based on the PRISMA 2020 flowchart, which shows the flow of information through the different stages of systematic review and the collection of a research sample of scientific studies. It maps the number of records identified, included, and excluded, as well as the reasons for exclusion. It thus ensures transparency and reproducibility of the selection process (Prisma, 2020). We retrieved research items or metadata of scientific publications from the Web of Science (WoS) Core Collection. This database contains high-quality scholarly articles from indexed, peer-reviewed journals and provides a relevant starting point for obtaining reliable results. The platform offers tools for searching, citation analysis, and bibliometrics. To filter relevant scientific publications, we used several search phrases that are key to exploring the topic, aligned with the stated research problem. These phrases were: “Education of gen* z students with artificial intelligence”; “Education of digital native* students with artificial intelligence”; “Education of ‘digital generation’ students with artificial intelligence tools”; “Artificial intelligence in education of ‘digital native*’ students”; “Artificial intelligence in education of ‘generation* z’ students”; “Artificial intelligence in education for ‘digital natives’”; „Generation Z students and AI-enhanced learning”; “Teaching ‘Generation Z’ with artificial intelligence”; “Personalized learning for ‘digital natives’ using AI”; “Innovative teaching methods for Generation Z with AI”. Their application generated a total of 58 entries.

We then used a record filtering technique to refine the results, within which we established inclusion criteria. These criteria were mainly the language and year of publication of the papers. We preferred English-language publications from the last ten years to obtain the most recent results incorporating the key language of international scientific publishing. As part of the exclusion criteria, we focused mainly on the extent to which the individual publications were relevant to the selected topic in terms of content. During the more detailed evaluation, we paid particular attention to key terms appearing in abstracts and titles. Naturally, the keywords of the identified entries had to relate to educating a generation of digital natives using artificial intelligence. Another exclusion criterion was the type of document. In this case, we excluded proceedings papers from the sample because, according to Öztürk et al. (2024), papers from proceedings are usually excluded since they are knowledge in development that may be replicated or later incorporated into full articles. Referring to a source to justify this step is important

when describing a procedure. After applying the filters, we were left with 44 records in the sample. We exported the dataset in RIS format, which is compatible with the visualization tool VOSviewer. Subsequently, the selected sample had to be stripped of duplicate records. We performed this step using the Zotero application, which allows identification and merging of duplicate records. After completing these steps, we arrived at a final sample of 43 scientific publications. The central step in the research is data analysis and visualization also known as “science mapping” or mapping of science. This bibliometric method provides a comprehensive picture of interactions between scientific actors, i.e., authors, articles, journals, concepts, keywords, universities, countries, and citations (Öztürk et al., 2024). After preparing a research sample of scientific studies, we focused on analyzing the co-occurrence of keywords and terms. According to Ondrisova (2011), this is the so-called “co-word” analysis, which captures associations between terms and keywords within the selected research sample. The results of the analysis are visualized in the form of maps. Öztürk et al. (2024) describe the analysis process as the calculation of similarity matrices and relationships between different items, such as authors, keywords, or scientific journals. Petrovich (2022) explains the analysis process in the context of scientific mapping in more detail. The procedure involves gathering keywords or terms from selected publications. These words are then grouped into thematic clusters, which can be described by two characteristics: centrality and density. The centrality of a cluster is determined by the number of links it has with other clusters, while density indicates the strength of internal links between keywords within the cluster itself. Based on these calculations, visualizations can be created, often referred to as strategy diagrams or cognitive maps. For this process, they chose VOSviewer software, which allows analysis without laborious manual calculations and advanced coding. VOSviewer also automatically generates the aforementioned network visualisations, streamlining the interpretation of results. Petrovich (2022) states that scientific maps can be used to answer questions such as: What are the main themes in a certain scientific field? How are these themes related to each other? How has a particular scientific field evolved over time? Who are the key players in a given scientific field?

Results

As mentioned above, the analysis was performed using the visualization software VOSviewer. With the help of this tool, similarity matrices were calculated, and maps were subsequently created. That software also allows the processed data to be exported in CVS format, which we later used to

create tables and graphs. In the next part of the study, we present the results obtained. Educating a generational cohort of digital natives through artificial intelligence is not new in academic research. However, based on the analysis and the data collected, it can be concluded that researchers have started to focus more intensively on the selected topic earlier during the last four years. This trend is understandable, as the tools of generative AI have become more widespread. Figure 1 shows the evolution of the number of published studies over the last ten years. The trend graph shows a noticeable increase in publications in 2021. The highest number of publications was recorded in 2024, when academics published a total of 22 scientific studies within our selected database.

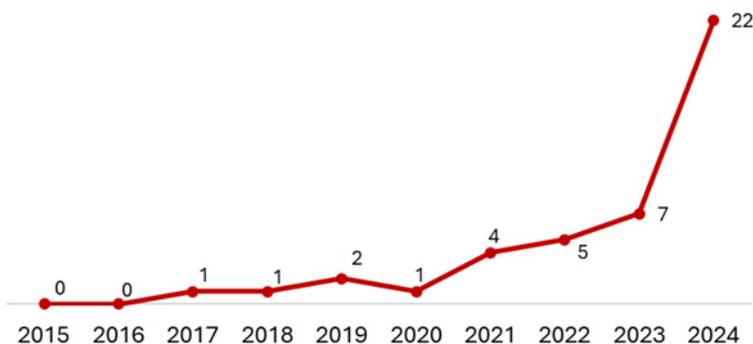


Figure 1: Evolution of the number of published studies over ten years

Source: Own processing (2024).

Map of Co-occurrence of Keywords

Within the results of the bibliometric analysis, we rely on the information presented in the generated visualizations. Petrovich (2022) states in his study that the nodes shown on the map represent the most frequently occurring concepts or keywords within the selected topic. Connections between concepts are also visible if the concepts occur together in the same title, abstract, or among keywords. It is also visible on the map that individual nodes are distinguished by colour. The colour of a node corresponds to the cluster to which the classification algorithm assigned it. The location of nodes on the map corresponds to their co-occurrence, meaning that terms that frequently occur together are positioned closer to each other. Our analysis identified five thematic clusters, which can be seen in the visualization of

the network map of co-occurrence of keywords (see Figure 2). The clusters are colour-coded, and the set of nodes in each cluster represents a particular theme or concept within scientific research. Based on the keywords (cf. Table 1), we can infer that Cluster 1 is thematically focused on motivational factors in the learning process, particularly the terms “beliefs,” “emotions,” “engagement,” and “self-efficacy.” The terms “automated writing evaluation,” “feedback,” “formative assessment,” “pedagogy,” and “validation” in the concept of learning point to the theme of assessment and feedback. Cluster 2 is thematically focused on digital change and transformation in education, which is particularly reflected in the keywords “competences,” “digital tools,” “digital transformation,” “future,” “generation z,” “impact,” and “students.” Keywords “education,” “chatgpt,” “information,” “internet,” “model,” and “web” in Cluster 3 indicate a thematic focus on the use of technology in education. Cluster 4 contains the keywords “artificial intelligence,” “digital natives,” “gen z,” “higher education,” “challenges,” “innovation,” and “sem.” These refer to innovations and challenges in education, with an emphasis on the use of artificial intelligence. Keywords “augmented reality,” “technology,” and “virtual reality” included in Cluster 5 refer to interactive technologies such as AR and VR.

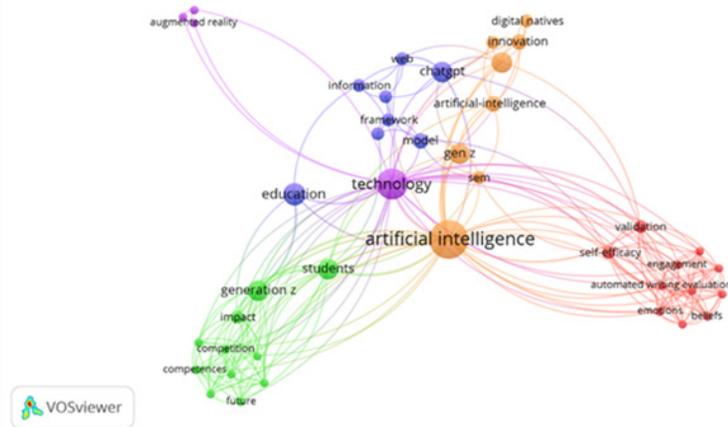


Figure 1: Network map of keyword co-occurrence
 Source: VoSviewer, own processing (2024).

Table 1: Keyword co-occurrence, connections, and clusters

Author's keyword	Cluster	Number of occurrences of the keyword	Number of links of the keyword
artificial intelligence	4	17	31
artificial-intelligence	4	3	7
augmented reality	5	1	2
automated writing evaluation	1	1	12
beliefs	1	1	12
challenges	4	2	4
chatgpt	3	5	9
competences	2	1	12
competition	2	1	12
digital natives	4	2	3
digital tools	2	1	12
digital transformation	2	1	12
education	3	6	5
emotions	1	1	12
engagement	1	1	12
feedback	1	1	12
formative assessment	1	1	12
framework	3	2	3
future	2	1	12
gen z	4	5	6
generation z	2	5	13
higher education	4	5	9
impact	2	2	13
information	3	2	5
innovation	4	3	6
internet	3	2	6
learners	1	1	12
model	3	3	7
pedagogy	1	1	12
perceptions	2	1	12
performance	3	2	4
planned behavior	2	1	12
program	1	1	12
self-efficacy	1	2	14
sem	4	2	7
students	2	5	16
sustainability	2	1	12
technology	5	11	33
validation	1	2	14
virtual reality	5	1	2
web	3	2	5

Source: Own processing (2024).

Term Co-occurrence Map Based on Text Data

Figure 5 shows a network map where we identified five clusters. Cluster 1 includes the terms “acceptance,” “digital native,” “educator,” “effectiveness,” “influence,” “intention,” “knowledge,” “role,” “skill,” and “usefulness.” From these terms, we can conclude that the cluster is thematically focused on education, learning, and the development of digital native competencies. Cluster 2 includes the terms “assessment,” “context,” “digitalization,” “evaluation,” “gen z student,” “chatgpt,” “iot,” “risk,” “society,” and “trust,” which are related to digitalization and evaluation in Gen Z education. Cluster 3 includes the terms “deep learning,” “effect,” “explanation,” “gamification,” “chatbot,” “impact,” “learning,” “teaching,” “understanding,” and “user.” Based on these terms, the third cluster is thematically focused on artificial intelligence technologies in education. Cluster 4 contains the terms “educational software,” “expectation,” “gen z,” “generation z,” “implication,” and “teacher.” These terms indicate the topic of digital technologies in the education of Generation Z. Cluster 5 contains only two terms, namely “academic performance” and “AI literacy,” which relate to academic results and literacy in the field of artificial intelligence.

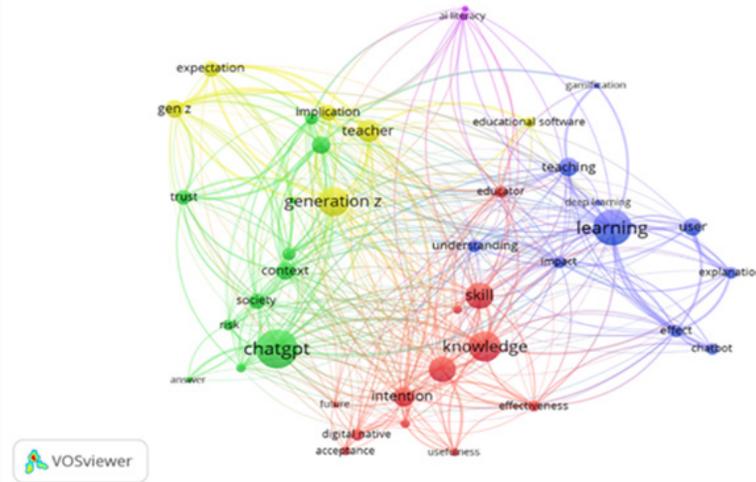


Figure 2: Network map of co-occurrence of terms in the text
 Source: VOSviewer, own processing (2024)

Table 2: Co-occurrence, connections, and clusters of terms

Author's keyword	Cluster	Number of occurrences of the keyword	Number of links of the keyword
academic performance	5	5	9
acceptance	1	7	10
ai literacy	5	6	9
answer	2	5	6
assessment	2	13	24
context	2	13	27
deep learning	3	5	12
digital native	1	9	13
digitalization	2	7	18
educational software	4	8	5
educator	1	9	28
effect	3	10	20
effectiveness	1	8	20
evaluation	2	10	23
expectation	4	12	13
explanation	3	9	12
future	1	5	20
gamification	3	5	4
gen z	4	13	21
gen z student	2	9	23
generation z	4	22	34
chatbot	3	9	9
chatgpt	2	29	20
impact	3	9	26
implication	4	12	29
influence	1	7	22
intention	1	15	23
iot	2	5	6
knowledge	1	23	26
learning	3	27	32
risk	2	8	22
role	1	19	28
skill	1	20	27
society	2	12	25
teacher	4	17	23
teaching	3	14	22
trust	2	11	14
understanding	3	10	26
usefulness	1	6	11
user	3	13	12
world	1	7	14

Source: Own processing (2024).

Conclusion

The paper aimed to capture the development and trends of research on the education of the generational cohort of digital natives using artificial intelligence (AI). As already mentioned in the methodology, the paper used word co-occurrence analysis, i.e., keywords of authors and terms found in the titles and abstracts of scientific studies. The purpose of applying the word co-occurrence analysis technique is, according to Donthua et al. (2021), to identify and examine the most important keywords/terms and the relationships between them, with words converging into a cluster representing a topic in the research area. Five clusters were identified on the keyword co-occurrence network map (Figure 1). Based on the above findings, it can be stated that academics focused most of their research on the use of artificial intelligence in the education of Generation Z, on motivational factors in the learning process, assessment and feedback, digital change and transformation in education, the use of technology in education, innovations and challenges in education with an emphasis on the use of artificial intelligence, and on interactive technologies in education. Figure 5 shows a network map of term co-occurrence, where we also identified five clusters. We determined their thematic focus based on the terms included. The topics of the clusters are mainly: education and development of digital natives' competencies, digitalization and assessment in the education of Generation Z, artificial intelligence technologies in the field of education, digital technologies in the education of Generation Z, academic achievements, and literacy in the field of artificial intelligence. Therefore, scientists also dealt with the above areas as part of their research on the selected topic. The data obtained on the temporal development of scientific publications shows that academics began to deal more intensively with the selected topic after 2022. This year, OpenAI presented the first free model of the ChatGPT tool to the public. However, we noticed on the development graph that four records were published on the topic in 2021, which brings us to one of the limitations of the presented work. When collecting data, we relied only on the Web of Science database and did not include records from other scientific databases in the sample, which could potentially affect the final sample size and thus the results of the time evolution and analysis. It is also worth mentioning that, in the context of applying the method of word co-occurrence analysis, the disadvantages of its use must be considered. Words are extracted from the titles of articles, abstracts, and sometimes from entire texts. According to Donthua et al. (2021), it should be considered that words are used in multiple contexts, and some may be too general, which can complicate their assignment to one thematic grouping. As part of the research, we focused on clusters, or groups of research areas, and also on connections with nodes carrying the

terms “generation z”, “gen z”, and “digital natives”. Using this approach, we identified current directions in research on the use of artificial intelligence in the education of Generation Z. This knowledge can serve as a basis for proposing directions for further research on the selected topic. Considering that the results clarify the current state of research, it is possible to focus on specific streams or under-researched areas in further research.

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Abstract

The main objective of the present paper is to capture the developments and trends in research on the education of a generational cohort of digital natives using Artificial Intelligence (AI). The starting point of the study is the application of a scientific mapping approach in the research part of the paper. The first phase of the investigation consists of collecting data, i.e., scientific publications from the Web of Science database, and sorting them according to the PRISMA 2020 development scheme. The second phase focuses on the analysis and visualization of the obtained metadata on scientific publications using the VOSviewer software. The obtained records are analyzed based on bibliometric characteristics, namely the co-occurrence of words in abstracts, titles, and author keywords, related to the education of the selected generational cohort. By identifying research trends on the education of Generation Z through artificial intelligence, the study has the potential to stimulate further

research on the topic or to highlight specific research directions or under-researched areas within this field.

Keywords: research trends, education, Generation Z, artificial intelligence, bibliometric mapping

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