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**Research Article**

# A Study of the use of ChatGPT as a Data Analyst for Empirical Investigations using Machine Learning-Assisted Quantitative Data Analysis

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**ABSTRACT**

**Purpose**:ChatGPT and its variations that use generative artificial intelligence (AI) models have quickly gained attention in scholarly and media debates over their possible advantages and disadvantages in a number of areas related to the economics, democracy, society, and environment. To help people make well-informed decisions under uncertain circumstances, decision scientists (DSCs) examine intricate dynamic systems and processes. AI is positioned as a new technology that helps with learning customization and encourages discussion about teaching methods in educational institutions worldwide.

**Aim**:This study examines the innovations and evolutionary patterns in DSC research and teaching to reveal the changes throughout time.

**Methods**:We employ the science mapping method, text analytics, and metadata from bibliographic databases to evaluate thematic and social structures.

**Results**:Results emphasize data science techniques, such as business/learning analytics and data mining, as crucial elements.Technological developments, advancements in computer science, and engineering procedures are examples of how DSC education and research are evolving in tandem with practice. A substantial part of scientific output is also made up of sustainable education via online or virtual learning. The development of DSC education and research demonstrates new pedagogic methods and techniques, including as simulations and games (often known as "playing and study").

**Conclusion**:Even if there are obstacles (academic integrity, plagiarism, intellectual property breaches, and other ethical and legal concerns), generative artificial intelligence (GenAI) has been used in the modern period in teaching, learning, and scholarly activities (e.g., ChatGPT). In order to overcome some adoption barriers for GenAI, future studies will include and use AI automated detection systems.

**Keyword**: Learning Analytics, ChatGPT,Pedagogical,Generative Artificial Intelligence,Text Analytics,Decisions scientists', Simulation,AI Automatic Detection,GenAI, engineering process Innovations,Complex Dynamic Systems,Technological Transformation,, ChatGPT

## I. INTRODUCTION

Digital technologies have had a significant impact on modern civilization, altering how people communicate, connect, and learn. Among the most significant shifts is the democratization of knowledge and information access [1]. People from a variety of social situations may now access educational and cultural resources that had previously only accessible to a select few thanks to the growth of the internet and the growth of cell phones, which have made information easily accessible. In addition, [1, 2], digital technologies have prompted a paradigm change in the educational model by encouraging flexibility in education and student customisation.

Learning may be made more independent and efficient by tailoring the material and approach to each student's unique requirements via the use of digital games, mobile apps, software for learning, and online teaching platforms, among others [2, 3]. A more inclusive education that is tailored to the demands of the twenty-first century may be possible with this student-centered strategy, which has the ability to overcome the constraints of conventional learning.

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ChatGPT is a natural language processor tool that lets you talk to a chatbot using artificial intelligence (AI) technology. Answers and assistance with many tasks may be obtained using this language model. OpenAI developed ChatGPT, which was made available on November 30, 2022. The Generative Pre-Trained Transformer (GPT) architecture, which includes GPT-3 and more recent versions GPT-3.5 and GPT-4, is the large language model (LLM) architecture on which it was constructed [4].

Deep learning is used by these autoregressive language models to produce writing that is human-like. Books, articles, blogs, and other websites provide a vast quantity of textual data that is used to train these kinds of models. Using both supervised and reinforcement learning, ChatGPT's language model was fine-tuned. As stated by OpenAI, ChatGPT is special and strong because it uses the Reinforcement Learning on Human Feedback (RLHF) technique [5, 6]. Approximately 3,500% more people visited OpenAI when ChatGPT was released at the end of November 2022, from 18.3 million to 672 million visits. The growing number of users of ChatGPT and OpenAI is seen in Figure 1.

Table 1 Daily worldwide visitors to the ChatGPT platform and OpenAI's website.

| Month | ChatGPT's Weekly Active Users | OpenAI's website |
|---|---|---|
| Apr-25 | 800 million | 600 million |
| Feb-25 | 400 million | 300 million |
| Dec-24 | 300 million | 250 million |
| Oct-24 | 250 million | 200 million |
| Aug-24 | 200 million | 100 million |
| Aug-23 | 100 million | 50 million |
| Jan-23 | 50 million | 30 million |
| Dec-22 | 30 million | 20 million |

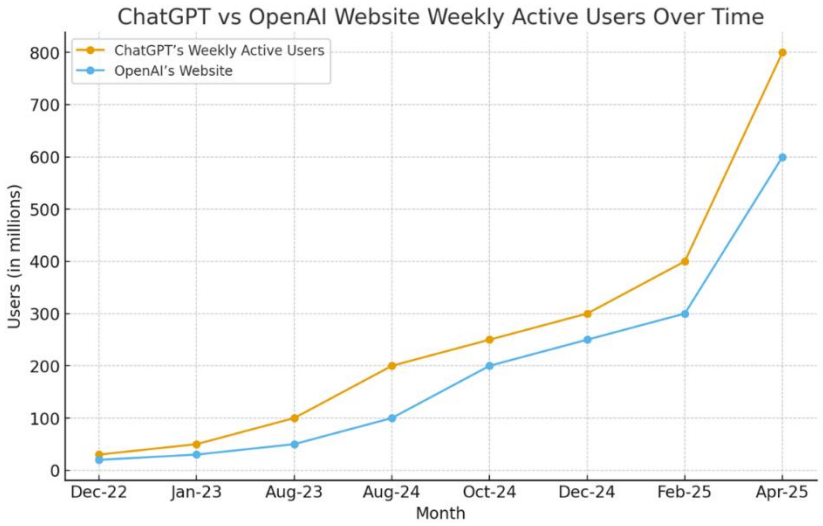


Fig.1 Daily worldwide visitors to the ChatGPT platform and OpenAI's website.

ChatGPT has been used to assess input and take action in a variety of academic and non-academic domains.By evaluating data from sensors or other monitoring equipment, for example, it may be used to remotely monitor patients and provide real-time insights into their health state [1, 6]. According to further studies, ChatGPT may help accounting professionals become more productive and efficient by changing their working processes [7]. Additionally, a number of academics demonstrated ChatGPT's capacity to generate short tales using the data users provide to the network.

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Additionally, companies have been using ChatGPT to enhance human productivity by automating monotonous jobs and facilitating more interesting user interactions.

The adoption of AI apps by students in higher education has significantly increased during the last two years. Numerous apps, like ChatGPT, are used for different objectives. The global educational community is debating this tendency, especially at the higher education level.Although the majority of researchers disagree with this conclusion, some academic institutions have even outlawed AI [7, 8]. The ideal course of action, according to academics, is to critically incorporate AI into the educational process using a set of standards that covers the incorporation of AI into learning, teaching, and evaluation. Many initiatives suggest and create artificial intelligence (AI) tools to enhance college students' learning.

As an example, uses modern technology to provide a new teaching framework that fosters both fundamental abilities and 21st-century competences. An open-access toolbox improved by AI will assist this framework, building on the advantages of learning analytics and big data [7, 8].It gives various stakeholder types comprehensible suggestions for intelligent discovery of resources and search, as well as for creating customized learning profiles that take into account the traits, requirements, and preferences of particular actors. Aug MENTOR will use the latest developments in Explainable AI, Creative Pedagogy, Pedagogical Design, and Knowledge Representation and Reasoning for educational objectives.

Chat GPT was regarded as a technical innovation of the highest magnitude when it was introduced on November 30, 2022 [7, 8]. The OpenAI-created chatbot model garnered more than a million users in five days, sparking intense interest and debate across the world.Businesses from the internet and technology sectors, as well as traditional and physical businesses, joined the flurry of development that followed the introduction of Chat GPT, creating a variety of application products based on Chat GPT [7, 8]. In addition to launching a new Chat GPT search engine and Edge browser, Microsoft intends to integrate it with all of its business divisions, including Office, Azure, GitHub, and Bing. Additionally, Google unveiled Bard, a chatbot service [8, 9], and partnered with Anthropic, an AI firm, to create Claude, an AI assistant that would improve user experience. Chinese internet giant Baidu finished testing its ERNIE Bot internally in March 2023 and made it available to a select group of customers. The growing adoption and use of Chat GPT technology, together with the ongoing advancement of artificial intelligence technology across a range of domains, are marked by this sequence of application and development of products.

The GPT-3.5 design serves as a platform for ChatGPT (GenerativePre-trainTransformer), a large language model (LLM). In order to achieve multi-round computer-human dialogue with the aid of natural language, it employs the logic of "big data + big computational resources + algorithm = intelligent model," which can extract useful information from massive text data and, through training, build more complex and humanized works to output responses and feedback in the form of text.The creation of Chat GPT technology has the potential to revolutionize human lifestyles, provide hitherto unheard-of digital experiences, and improve people's quality of life. But there are also possible drawbacks to this technique [9, 10]. AsChat GPT technology develops and is used, it has the potential to replace a large number of occupations that include activities that are outside the scope of artificial intelligence.This would raise unemployment rates and have a detrimental impact on the economy as a whole.Furthermore, the use of Chat GPT technology may make individuals more dependent on AI, which would impair their capacity for critical thought and judgment.

A new paradigm known as the "digital workspace" allows employees to operate both online and in person. It makes it easier for workers to be more productive. Employees will be able to manage their work and communicate without time or location restrictions, save money on pointless commuting, and have greater flexibility thanks to this work arrangement [44]. Even when companies use IT to support digital work, employees still prefer their regular office schedules. Therefore, the shift to digitisation necessitates a psychological adjustment in the definition of work from a 9-to-5 office job to one that is not limited by time or location. The latter viewpoint aims to do tasks efficiently [44, 45].

### 1.1 Development: from investigating AI to Chat GPT Plus

A group of scientists convened at Dartmouth College in 1956 to investigate the potential for automating using machine learning and other technologies that went beyond human cognition [4, 9]. Although the fact that the conference failed to produce a consensus, it did initiate a dramatic shift in the area of artificial intelligence (AI) which impacted later generations.

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There have been three major rounds of advancement in AI across time. The first surge of interest in AI began in the 1950s and 1960s with the development of the Turing test. In order to satisfy the demands of AI development, computer technology, programming, [9,10], and algorithm theory were still insufficient at the time. The Hopfield neural network and the BT training algorithm were introduced in 1982, marking the second peak of artificial intelligence [11]. The growth of AI was further aided by the creation of technologies like translating and voice recognition as well as Japan's Fifth Generation Computing Program. The advancement of AI did, however, briefly stall because of hardware and algorithmic restrictions [12]. Big data, machine learning techniques, AI chips, and massive parallel computing are the four main drivers that have emerged since the turn of the twenty-first century due to the rapid development of information technology, including cloud computing and big data. These factors have created previously unheard-of opportunities for the advancement of AI. AI has been a part of deep learning's third wave since 2006 [13], and it is still expanding and evolving. By the end of 2022, OpenAI's Chat GPT was heralded as the most sophisticated intelligent machine that was most likely to pass the Turing test, bringing in a brand-new, exciting age of AI [15].

The repeatability of previous research results is the basis upon which we evaluate ChatGPT's usefulness.In order to do this, we use a number of assessment criteria for the quality of analysis using ChatGPT, such as the appropriateness of the analysis processes, the functionality of the code that is created, and the accuracy of the findings' presenting [19]. Thus, our goal is to learn which steps in the code and the output-producing stages of data analysis show promise for AI assistance and what types of problems could occur if a novice user uses ChatGPT's free edition without prompt optimization when interacting with the AI [20].

### 1.2 Resistance to Chat GPT was brought about by academic integrity concerns

Chat GPT is a new artificial intelligence system that has drawn interest and controversy from many facets of society because to its broad use in education. Chat GPT has a lot of benefits for increasing communication and learning efficiency, but there are drawbacks and even hazards to its uses as well.Some individuals are concerned that Chat GPT might negatively affect interpersonal interactions, even if it is anticipated to enhance interpersonal communication methods and efficiency [20]. However, utilizing Chat GPT to do assignments might result in academic dishonesty and cheat habits, which have already drawn criticism and resistance from certain academics, organizations, and institutions [20, 21]. The academic community has also expressed considerable criticism to and worries over the abuse of Chat GPT in scientific studies [21].

Active conversation practice and sufficient immersion in language learning situations have a significant impact on learners' communicative ability and language competency. However, a challenge for language teachers is the hesitancy of many pupils to communicate in their second or foreign language. Chatbot researchers claim that a more realistic and engaging language environment, enabled by chatbot-supported activities, can improve student language learning outcomes [18]. Highlighted how chatbots can assist students who are apprehensive when honing their language abilities, as opposed to speaking with a human companion. Chatbots may potentially reduce the transactional barrier between students and teachers in an online learning environment. The notion of transactional distance states that in an online learning environment, there is a psychological and communication gap between the teacher and the student [21], which could lead to misunderstandings. Students are more likely to be satisfied with their learning environment when there is less transactional gap between them. Chatbots can help reduce the transactional distance by enabling students to interact with the course material through dialogue.

Nearly 89% of American undergraduates use Chat GPT to do their homework, with 53% utilizing the program to write papers, according to a recent Survey. Furthermore, Chat GPT is used by 22% of students to create paper outlines and by 48% of participants during tests [22]. It's important to keep in mind, too, that some students not only do homework using Chat GPT effectively, but also get great grades [25]. As a result, students become too dependent on Chat GPT, which eventually impairs their capacity for critical thought, exploration, verification, and active summarization [24].Teachers find it challenging to ascertain if learners are utilizing Chat GPT. The development and learning outcomes of kids will be significantly affected if this tendency continues.

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### 1.3 Promoting instruction and learning: some academics support incorporating Chat GPT into the educational framework

Chat GPT is a potent tool in the realm of education that can be used to help with language acquisition and provide instructional material [23]. This program is a valuable resource for teachers and students since it can produce a variety of documents automatically including articles, abstracts, and textbooks with little human involvement [24]. To create a more engaging and imaginative learning environment, teachers may integrate Chat GPT into a more comprehensive instructional resource by using cognitive technologies. Students may further investigate points of knowledge to create a really intelligent educational system by using Chat GPT for self-inquiry. As a result, there are several voices in favour of using this clever tool in the classroom. It should be acknowledged, therefore, that there are several obstacles to the use of Chat GPT in the educational sector [26], including concerns about data quality, knowledge bases, privacy, and moral considerations.

According to Professor Bhaskar Vira of the University of Cambridge, students should not be restricted in their use of computing technologies, such as Chat GPT and other innovative tools.Students' learning efficiency and mastery of material may both be enhanced by these resources.But in order to guarantee that students use these new tools in a way that upholds academic integrity, schools must modify their teaching strategies and testing requirements accordingly.Professor John Villasenor of the University of California permits students to utilize Chat GPT for projects in a similar manner [26]. However, it is more crucial to educate learners how to utilize these tools properly and efficiently in order to make sure that their learning experience is efficient and relevant.

### 1.4 Is there a chance? —A study on the viability of combining education with artificial intelligence

The challenges face education today and the profound effects of AI on education must be thoroughly examined before debating whether AI should be prohibited in academic settings [21]. From an international standpoint, there are numerous issues facing education today, such as unequal resource distribution, inconsistent quality of learning, a lack of educational content, antiquated teaching techniques, an excessive workload for students, and an inadequate system for evaluating education Figure 2. These problems seriously limit education's quality and fairness [18], impeding its advancement.

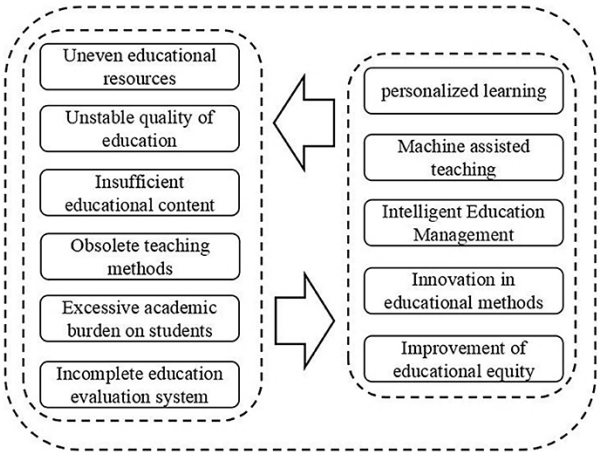


Fig. 2Concerns about education and the advancement of AI in the classroom.

The study of intricate dynamic processes and systems is the main goal of decision scientists (DSCs), who work to make well-informed decisions in situations that are uncertain. In order to evaluate operations, production, and processes, give understanding and insights into complex systems to improve prudent decision-making, and assess alternatives, the DSC field integrates problem-solving methods, techniques, [14], and strategies from a variety of disciplines, including mechanics, economics and business, psychology, and statistics and mathematics. The area of DSC crosses several conventional departmental lines, including those in business, engineering, psychology, and mathematics [26]. Operational/operations research (OR), managerial sciences (MS), and computer and statistical sciences are further cutting-edge and related fields that make substantial contributions to the development of the DSC area.

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Computer-generated programs for role-playing were developed as a result of the mid-20th century's introduction and continuing growth of computer technology. These applications were then included into DSC academic programs as a teaching tool and for industrial training and practice. Later, this progress led to the creation and adoption of visual interactive simulation and the first commercial simulation software packages, such as "SEE-WHY, FORESIGHT, WITNESS" [26]. Visual interactive simulations and modeling as a decision support system resulted from the ensuing change [21]. Computer simulation has evolved dramatically over time, giving rise to sophisticated 3D renderings. In 1969, the Decisions Scientists' Institute (DSI) was established to support the ongoing development and concretization of the DSC discipline, as other universities rapidly began providing DSC programs.

Additionally, as part of its efforts to advance the discipline via practice, research, and teaching, DSI established two specialist periodicals to share expertise in the area.The first of these, published in 1970, focused on DSC research and practice. Another publication published by DSI was established in 2003 with the goal of promoting DSC education and furthering the field [19]. This development showed DSI's dedication to giving researchers and educators a platform to exchange creative teaching methods and pedagogical strategies to teach students innovative techniques to meet industry demands in the fields of supply chain management, operations administration, and managerial science [19, 20].

This study examines the innovations and evolutionary patterns in DSC research and education to identify changes from 2000 to 2022. This research specifically aims to accomplish the following five goals:

- Assesses the citation effects and growth patterns in DSC education research from 2000 to the present.
- Analyze the text analytics, themes dynamics, and thematic structure of DSC education research to see how it has changed over time.
- Identify potential future research directions.

## II. METHOD AND MATERIALS

### 2.1 Bibliometric Evaluation

This study evaluates the development and trends of DSC education research from 2000 to 2022 using quantitative or evaluative bibliometric analysis/science maps approaches and visual analytics [29, 31]. The results, citation impact, topics, and research patterns are all revealed by the quantitative bibliometric investigation.

The theme's development throughout time is highlighted by analyzing the thematic structure and patterns. Topics and themes are mapped with the use of visual analytics, which also creates visualization.The research uses the VOSviewer and an R-based Bibliometrix, two complimentary bibliographic software, in the studies above. Both programs are publicly downloadable and open-source. Although the R-Studio environment includes the Bibliometrix application package [28, 29], the VOSviewer is a standalone solution that may be used to provide bibliographic networks evaluation and visualization capabilities [29]. Both of the bibliometric assessment tools are capable of processing "big data" and generating numerical outputs.

### 2.2 Database Survey and Information Gathering

The following steps are involved in carrying out the database survey and gathering data for this study:

- Determining the search terms,
- Creating search parameters, [18, 19],
- Determining which bibliographic databases, and
- Performing the survey.

Table 2Database survey and data gathering procedure: retrieval and search, filtering, screening, and publishing selection criteria.

| Activities/Focus | Criteria |
|---|---|
| ***Data sources (s)*** | Search the SCOPUS Biblography Database. |
| ***Search Criteria*** | SUMMARY: ((("decision scientist") AND ("training" OR "learning")) OR SOURCETITLE: ((("decision scientist") AND ("training" OR " |

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| | | |
|---|---|---|
| | learning")); The periods covered are 2001–2022. speaking English or a translation into English in the past; 5,570 in all. | |
| ***Selection, Filtering, and Screening of Documents*** | | Selection, Filtering, and Screening of Documents |
| ***Filtering*** | 250 documents were deleted, including Book (240), Report (4), Undefined (6), and [5513-250 = 5,263]. | |
| ***Screening*** | Review 5,263-3,907-=1,413 (materials not addressing Decisions scientists in education genre) and 8 irrelevant papers were filtered out. | |
| ***Final DocumentsSelection*** | 1413 publications in all from SCOPUS between 2001 and May 27, 2022 (the date of the last research review). For the analysis, documents were obtained in text forms (.txt or.csv documents). | |

## III. RESULTS AND DISCUSSION

In this part, the findings of the quantitative bibliometrics study are presented, the outputs are visually represented, and the consequences are discussed [29, 30].

### 3.1 Data Summary and Sample Description

A summary of the data and preliminary findings are presented in this section. The dataset used for the analysis was derived from the final, vetted, and chosen papers on DSC training published between 2000 and 2022.Bibliometrix, an R-based software program and VOS viewer, was used to analyze and visualize the 1413 articles that were retrieved as metadata in text format after the final screening to exclude scientific publications (SCP) that did not cover the issue of interest [18, 19].500 sources included the 1413 articles (book chapters: 3%, conference sessions: 42%, and journals: 55%). The complete data summary [29, 30] is included in Table 3.

Table 3 An overview of the information for Decisions scientists' research on artificial intelligence-supported learning and education.

| Description | Results | Description | Results |
|---|---|---|---|
| Publication Years | 2000-2022 | ***information about other papers;*** | |
| Sources | 500 | Average Age of Documents (years)* | 9.46 |
| ***Details of the documents:*** | | *As of July 31, 2022: Publication. | |
| Total released: 777 (55%) journal articles | | Book Chapters: 48 (36%); Conference Papers: 580 (43%). | |
| The annual growth rate of publications | 7.96 | ***Author and Cooperation:*** | |
| Citations per document on average | 12.2 | Authors | 3,356 |
| Total citations | 43,468 | Singal-Authored document authors | 287 |
| ***Content of the documents:*** | | | |
| Keywords Plus (ID) | 5,689 | CO-Author according to papers | 2.59 |
| Author's keywords (DE) | 3,589 | International proportion of co-authorships | 15.59% |

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### 3.2 Bibliographic Analysis of Achievement

The bibliographic evaluation of impact and performance bibliometric examination for the SCP trend are presented in this section, which tackles the first study objective1.

#### 3.2.1 Trends in Scientific Publications

Over the last 22 years (2000–2022), the publishing trend indicates a mean of 57 SCPs annually.2011 had the most articles in a single year (178), at least three times the average for the year [1, 8]. Although 2022 is less than half a year, the research productivity during the 2000–2009 ten-year period was low (257 or 18%) compared to the following ten-year period (2010–2019), which recorded more than twice the value (778 or 55%) [18, 19], and 2020–2022 May, (378 or 25%). Upon closer examination, it is discovered that the significant rise in the SCP for 2011 was caused by a surge in the publishing of conference proceedings. Of the 590 proceedings papers for the whole time, the proceedings papers made up 21% and 70% of the SCP for the year. The comprehensive overview of the collected data is shown in Table 3.

#### 3.2.2 Analysis of References Trend and Effect

The second part of the first study goal 1 examines how the SCP's citations have affected DSC education research, including games, simulation, and artificial intelligence in learning and instruction [17, 18]. 953 of the papers received 17,125 citations overall, with an average of 12.12 per document, according to the statistics. Furthermore, whilst 67% of articles received at least one citation, 460, or 33%, did not (Table 4).

Table 4 The effects of citations on publications annually (2000–22).

| Years | SCP | TC | MeanTC/SCP | MeanTC/CY | CY | NC | NC% |
|---|---|---|---|---|---|---|---|
| 2000 | 24 | 216 | 15.69 | 0.89 | 25 | 3 | 14.0 |
| 2001 | 18 | 549 | 36.98 | 1.59 | 22 | 3 | 18.9 |
| 2002 | 10 | 1890 | 131 | 5.49 | 16 | 2 | 20.96 |
| 2003 | 16 | 385 | 26.96 | 1.09 | 3 | 9 | 58.9 |
| 2004 | 12 | 210 | 11.15 | 1.08 | 11 | 8 | 57.9 |
| 2005 | 79 | 59 | 56.96 | 2.08 | 21 | 17 | 47.6 |
| 2006 | 22 | 879 | 14.58 | 2.0 | 0.29 | 19 | 51.9 |
| 2007 | 36 | 549 | 14.58 | 0.89 | 16 | 11 | 39.6 |
| 2008 | 59 | 696 | 7.89 | 0.48 | 14 | 16 | 51.89 |
| 2009 | 77 | 1089 | 18.96 | 0.14 | 11 | 12 | 12.55 |
| 2010 | 41 | 968 | 17.69 | 0.24 | 10 | 19 | 11.96 |
| 2011 | 148 | 1096 | 60.09 | 1.49 | 10 | 9 | 16.44 |
| 2012 | 94 | 985 | 18.96 | 2.46 | 9 | 22 | 42.69 |
| 2013 | 79 | 669 | 15.2 | 1.49 | 8 | 9 | 14.25 |
| 2014 | 49 | 689 | 8.48 | 1.25 | 9 | 7 | 11.95 |
| 2015 | 65 | 489 | 14 | 1.29 | 9 | 9 | 14.85 |
| 2016 | 66 | 1085 | 2.01 | 8 | 9 | 12 | 17.25 |
| 2017 | 78 | 849 | 21.96 | 1.49 | 4 | 11 | 15.96 |
| 2018 | 56 | 986 | 14.28 | 2.86 | 7 | 9 | 14.5 |
| 2019 | 78 | 471 | 6.42 | 85 | 9 | 2 | 11.56 |
| 2020 | 88 | 607 | 6.8 | 1.8 | 8 | 14 | 19.81 |
| 2021 | 89 | 101 | 1.51 | 1.41 | 9 | 14 | 15.21 |
| 2022 | 48 | 18 | 0.65 | - | 0 | 35 | 98.98 |
| | 1332 | 15535 | 522.8 | 124.51 | 240.29 | 272 | 679.61 |

#### 3.2.3 Impact Analysis of Source Citations and SCP Productivity

An additional component of the citation architecture looks at the effect and SCPs of the sources being cited. Tab 1e 2 shows the 500 sources that published the 1413 papers evaluated in the study (book chapters: 46 or 3 percent;

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proceedings: 590 or 42%; journals: 777 or 55%; [18, 19]). The Bibliometrix application's findings show which trustworthy sources published the most papers and received the most citations [46].

A specialized DSC education publication (Decisions scientists' publication of Innovative Education - DSJIE) is among the 16 most prestigious sources (fifteen articles and one conference proceedings) that are mostly interdisciplinary, as shown in Table 5 [29]. The DSJIE received far more citations than any other journal (3354, or 19.5% citations) and contributed 298 SCPs, or 21.1% of the total[45].

Table 5 Reputable sources by SCP and the influence of citations.

| Element | SCP | TC | PY_Start |
|---|---|---|---|
| The Journal of Innovative Education for Decision Scientists | 265 | 6484 | 2011 |
| The Operational Research Society's Journal | 31 | 485 | 2000 |
| System for decision support | 15 | 45 | 2007 |
| System for Journal Support | 86 | 69 | 2007 |
| IOP conference series: engineering and materials science | 456 | 45 | 2017 |
| IEEE Access | 69 | 25 | 2014 |
| Interface | 54 | 698 | 2003 |
| European Journal of Operational Research | 47 | 49 | 2001 |
| Cleaner Production Journal | 66 | 226 | 2003 |
| Professional Issues Journal for Engineering Practice and Education | 15 | 741 | 2001 |
| The International Journal of Educational Administration | 45 | 25 | 2004 |
| Management science | 4 | 19 | 2001 |
| Forecasting technology and societal shifts | 4 | 78 | 2007 |
| Operation research | 4 | 26 | 2001 |
| Austrian Apple Science | 5 | 23 | 2017 |
| The study of socioeconomic planning | 5 | 88 | 2010 |

### 3.3 DSC Education Research's Thematic Framework

In order to identify the changes, patterns, and growth of the study subjects over time, this section assesses thematic framework and themes dynamics of DSC research on education [28, 29]. The second study aim 2 is addressed by the findings of the scientific map of the DSC educational research and the topic organization of SCPs [30].

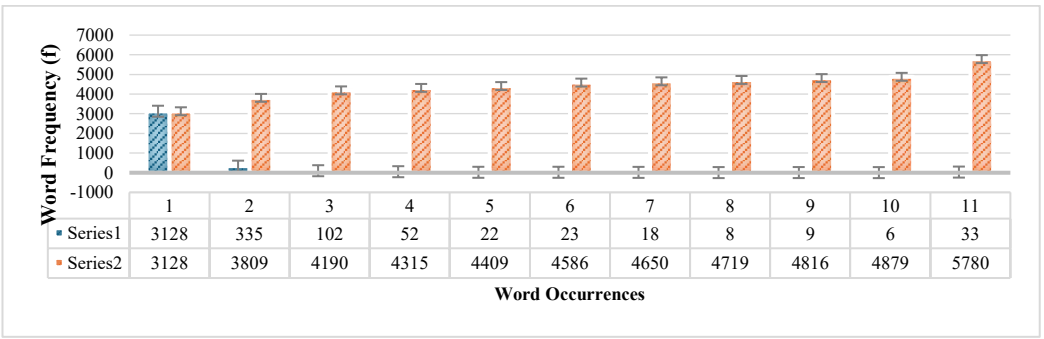


Fig. 3Text Analytics Findings for Cumulative Frequency and Unstemmed Word Occurrences.

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### 3.3.1 The Main Concepts and Themes

As previously said, the most commonly used keywords are those whose frequency (f) of appearances is greater than or equal to 10 (f >= 10) [31, 32]. Fourth-two (42 or 1%) unique keywords (unstemmed) that appeared 10 times or more were found using the bibliographic tool in the R-studio environment (Table 6), [28]. This resulted in a word frequency of 921 times (16.6%) of the 5,734 total occurrences [44, 45]. 27 keywords and themes were generated by manually stemming the 42 most common unique terminology. Combining phrases with the same meaning but various spellings is known as keyword stemming [25]. The findings for each of the major concepts are shown in Figure 4 (stemmed).

Table 6An examination of the main subjects in DSC education research from 2000 to 2022.

| Themes | 2000 | 2005 | 2010 | 2015 | 2020 | 2022 |
|---|---|---|---|---|---|---|
| Smoth (teaching/pedagogical approaches) | 94 | 96 | 95 | 99 | 98 | 97 |
| Smoth (Systems for Supporting Decisions) | 87 | 85 | 81 | 86 | 85 | 88 |
| Smoth (Analytics) | 82 | 84 | 80 | 84 | 78 | 87 |
| Smoth (E- learning) | 80 | 84 | 80 | 84 | 74 | 74 |
| Smoth (Investigative Education) | 78 | 79 | 78 | 82 | 71 | 76 |
| Smoth (Games & Simulation) | 75 | 78 | 74 | 81 | 69 | 75 |
| Smoth (Assistance in Making Decisions) | 72 | 78 | 78 | 80 | 68 | 68 |
| Smoth (Management of Operations) | 69 | 68 | 75 | 78 | 62 | 64 |
| Smoth (Management of Knowledge) | 68 | 67 | 75 | 74 | 61 | 62 |
| Smoth (Management of the Supply Chain) | 61 | 67 | 74 | 72 | 58 | 61 |
| Smoth (Data Mining) | 58 | 66 | 72 | 71 | 57 | 59 |
| Smoth (Management of Businesses) | 54 | 62 | 70 | 70 | 52 | 58 |
| Smoth (Management of Projects) | 52 | 61 | 65 | 68 | 52 | 51 |
| Smoth (Management and Leadership) | 49 | 58 | 62 | 67 | 51 | 50 |
| Smoth (Management and leadership) | 48 | 57 | 62 | 66 | 49 | 48 |
| Smoth (Learning Machines) | 47 | 54 | 60 | 65 | 48 | 47 |
| Smoth (Artificial Intelligence) | 46 | 53 | 54 | 61 | 47 | 46 |
| Smoth Innovation | 38 | 52 | 50 | 60 | 44 | 45 |
| Smoth ((Big Data) | 35 | 50 | 50 | 58 | 42 | 41 |
| Smoth (Making Decisions) | 32 | 49 | 48 | 54 | 39 | 40 |
| Smoth (Business intelligence) | 31 | 48 | 47 | 48 | 38 | 39 |
| Smoth (Science of Management) | 30 | 47 | 40 | 45 | 35 | 35 |
| Smoth (Analysis of Decisions) | 29 | 45 | 39 | 40 | 32 | 31 |
| Smoth (Enterpreneuship) | 29 | 39 | 30 | 38 | 30 | 28 |
| Smoth (Active Education) | 27 | 28 | 28 | 32 | 28 | 24 |
| Smoth (Distance Education) | 25 | 22 | 27 | 30 | 26 | 22 |
| Smoth (Sustainability) | 22 | 19 | 26 | 28 | 25 | 18 |

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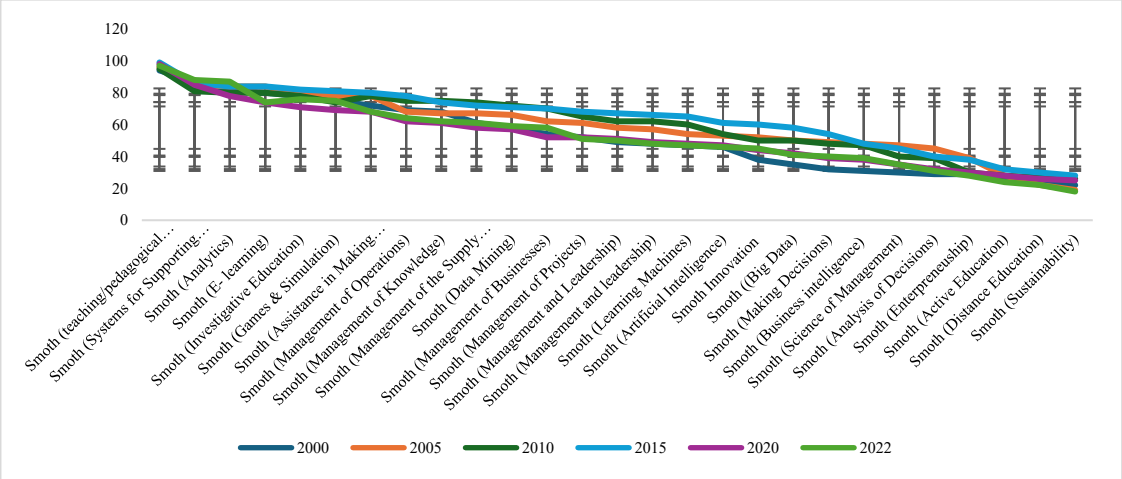


Fig. 4 Prominent Themes in DSC Education Research: A Trend Analysis (2000–2022).

### 3.3.2 Developmental Patterns in the Study of Education by Decision Scientists

This Section's theme development supports the tendencies of key phrases on DSC education that were covered in the preceding Section [18, 19]. The study focuses on the three-period strata of main research subjects.Ten years are covered by the first two strata (2000–2009, 2010–2019), [28], and the remaining five of the twenty-two years (2020–2022) are covered by the third segment.

Table 7 Development of Key Research Topics in Decisions Scientists' Education Studies, Such as AI and Simulation Games.

| | 2000-2009 | | | 2010-2019 | | | 2020-2022 | | |
|---|---|---|---|---|---|---|---|---|---|
| **No.** | **Themes: n=795 [23%]** | **f** | **LS** | **Themes: n=1903 [51%]** | **f** | **LS** | **Themes: n=1026 [28%]** | **f** | **LS** |
| 1 | Management of knowledge | 9 | 34 | Teaching and pedagogical approaches | 45 | 157 | Systems for decision support | 50 | 188 |
| 2 | Analysis of the data environment | 8 | 31 | E-learning and online education | 36 | 96 | Learning via experimentation | 23 | 89 |
| 3 | Systems for decision support | 8 | 29 | Systems for decision support | 33 | 88 | Artificial intellignece | 20 | 78 |
| 4 | Policy, technology, and management | 8 | 28 | Management of operations | 29 | 83 | Machine learning | 17 | 77 |
| 5 | The engineering and systems | 8 | 27 | Management of knowledge | 24 | 74 | Data mining | 17 | 68 |
| 6 | Management of projects | 8 | 26 | Management of supply chain | 21 | 65 | Analysis of data | 16 | 66 |
| 7 | Innovation | 7 | 25 | Learning via experience | 19 | 60 | Pedagogical strategies | 15 | 62 |
| 8 | Analysis of decisions | 7 | 24 | Management of projects | 18 | 59 | E-learning and online education | 14 | 59 |
| 9 | Business ownership and orientation | 6 | 23 | Educating using simulation and games | 17 | 55 | Management of the supply chain | 13 | 58 |
| 10 | Management of Change | 6 | 21 | Academic domains | 15 | 48 | Analytical business | 12 | 48 |

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| | | | | | | | | | |
|---|---|---|---|---|---|---|---|---|---|
| 11 | Information mining | 5 | 19 | Simulation | 14 | 38 | Big data | 11 | 44 |
| 12 | Efficiency | 5 | 18 | Information mining | 12 | 28 | Leadership | 9 | 34 |
| 13 | Learning inside an organization | 5 | 17 | Decision-making | 13 | 19 | Simulations and games | 9 | 32 |
| 14 | Making decisions | 5 | 15 | Innovation | 10 | 11 | Management of operations | 8 | 30 |
| 15 | Growth in the economy | 5 | 11 | Analysis of the data environment | 9 | 9 | Analytics for decisions | 8 | 28 |

- **The 2000-2009 First Phase**

The three most often examined subjects in the first section (2000–2009) are "decision supporting systems" (DSS), "knowledge management" (KM), and "data envelopment analysis" (DEA). Studies on "KM education and curriculum development," "Critical knowledge and expertise requirements of IS experts," and "Knowledge-based improvement, modeling, and artificial intelligence" were amongst subjects covered [29, 32].

- **The 2010-2019 Second Phase**

While other terms waned, some of the most well-known topics from the earlier era persisted.For instance, through studies like "university knowledge administration tool for assessing of the effectiveness and efficacy of learning," "knowledge management for educational software task administration," and " benchmarking utilizing information DEA," DSC instructors and investigators continued to be interested in KM, DEA, [33], and DSS.

- **The 2020–2022 Third Phase**

The third stage aligns with the waves of digitization and digitization, including the increased use of digital platforms, devices, and tools for everyday tasks like remote services and learning.The fourth industrial revolution (i4.0) [35], which brought about highly developed interconnected technologies through the Internet of Things (IoT), and the aftermath of the SARS-CoV-2 outbreak, which required the use of electronic platforms and technology, are some of the factors that contribute to rapid electronic commerce.

### 3.4 Visualization of Key and New Themes in DSC Education Studies

In this section, the theme organization of DSC studies on education is shown in a network map using text analytics and a scientific mapping approach. We utilized information on the major and new themes that emerged from text analytics using the bibliographic tool that was integrated into the R-Studio, as described in the preceding Section [36, 37].Terms with a frequency or occurrence of 5 or greater (f>=5) are included in the significant and developing themes (42, 78, respectively), which make up 120 unstructured unique keywords, or 3.2% of the 3,739 total.

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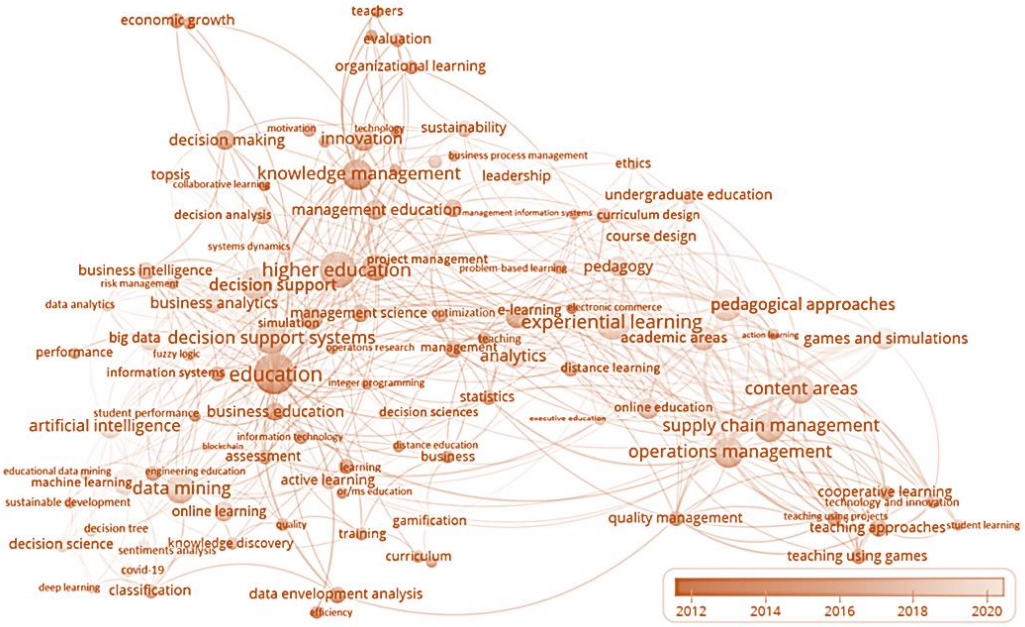


**Fig. 5** Themes in DSC education research and practice shown as networks.

Using the VOS Viewer tool, the results (Figure 5) display the themes categorized into five color-coded clusters:

- Among the topics covered in this Cluster are "education," "data envelopment evaluation" [37, 39], "organizational learning," "information management," "teaching using simulations," and more. It covers topics published between 2000 and 2012.
- This Cluster's themes were released from 2012 to 2014.Business intelligence, innovation, e-learning, operations management, OR/MS education, and more are some of the elements[38].
- Issued between 2014 and 2016 ("data mining," "ethics," "pedagogy," "decision support systems," and more).
- (See "pedagogical approaches," "experiential learning," and more) took place between 2016 and 2018.
- Themes published between 2018 and 2022 are included in this cluster, including "artificial intelligence," "business analytics," "big data," "machine learning," "games and simulations," and more.

### 3.4.1 The Themes That Occur the Least

The least frequently occurring research topics are examined in this section.This section's findings aid in addressing the third study goal. The motifs in question are those that appear four times or fewer ($f < 5$) [39, 40]. The bulk of the 3739 author words (3619 or 97%) are the least common topics. Additionally, this group indicates the least investigated subjects, which are often unexplored or newly developed areas of study [41, 42]. Additionally, node (circles) and edges (lines) are used to depict the network map. However, there are either very few or no interconnected linkages (edges) between the nodes since there hasn't been much study done on those subjects. The findings generated by the VOS Viewer platform on a network map are shown in Figure 6, which displays a less linked network of subjects over the time.

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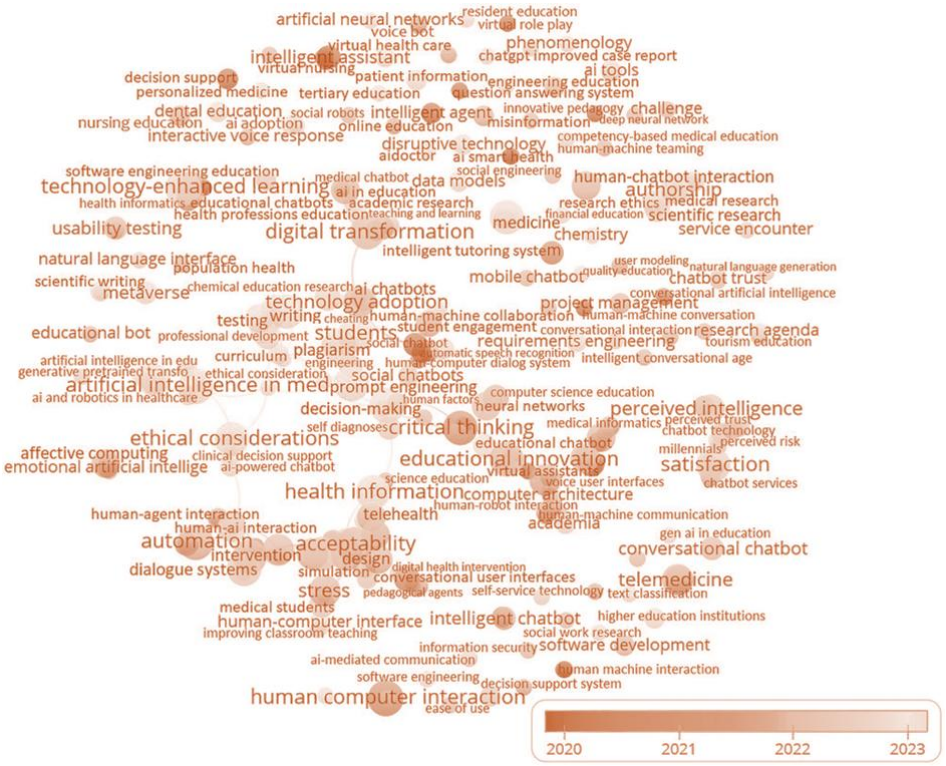


Fig. 6The least common topics (f < 5).

### 3.4.2 In DSC Education, Simulations and Gaming Analytics for Data, and General Artificial Intelligence

Data analytics, GenAI, and simulation and gaming were all included into DSC teaching at various points in time. The three educational approaches, however, have lately been used in workplace settings and as complementary integrated educational systems. By using these strategies, students' educational experiences and industrial training are improved [40, 41].Since the middle of the 20th century, DSC has used games like Monopoly Board to teach decision-making. Likewise, by simulating real-world settings and situations in the classroom, simulation games provide an experienced and practical learning opportunities by turning abstract ideas into concrete ones.

By allowing students to use their conceptual understanding in real-world circumstances, the practical scenarios improve decision-making and provide deeper insight into complicated real-world problems [41, 42]. The process of learning is made more interesting and pleasurable by simulation and games, which also provide a stimulating educational atmosphere and a virtual setting for active participation. Students may practice critical thinking and decision-making in realistic but risk-free surroundings by using the virtual world that simulation provides.

Two well-known domains implementing AI are OR/MS and the DSC discipline.The use of GenAI in education has more recently been seen as a disruptive technology that has the potential to completely transform conventional education as we know it [43]. There are several advantages of using GenAI in DSC education.DSC aims to improve decision-making, for instance, by modeling and simulating complex systems that might provide insight for decision-making.

Recent advancements in transformer-based language models pretrained on massive web corpora in a self-supervised setting include Megatron-Turing [14], GPT-4, Bloom-176B, LLaMA3, and the most recent models, Gemini and ChatGPT. These models not only provide state-of-the-art performance on NLP tasks but have also become general task solvers. LLMs outperform traditional pretrained LMs in terms of performance gains in downstream NLP tasks due to their greater capabilities. Many LLMs have been proposed in the literature since this breakthrough. Much of the research on the development of LLMs is based on the English language. More recent survey articles on LLMs, training datasets [42], and evaluation methods [43] present comprehensive overviews of transformer architectures, pretraining, and fine-tuning datasets. In contrast to these surveys, our contribution focuses on providing an overview of the existing work on the development of LLMs for European languages. European languages can be categorized into high resource, mid-

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resource, and low-resource languages. To the best of our knowledge, this is the first article that presents a comprehensive review of the existing work on the resources and development of LLMs for official European languages.

### 3.4.3 The Impact and Productivity of Nations

R-Bibliometrics' nation productivity and effect analysis yields the findings of the influence of citations and productivity of scientific publications on DSC education SCP throughout the research period (2000–2022) [45].China, Indonesia, the United Kingdom, and the United States are the four most productive nations. With nearly 31% of the world's literature coming from the USA, it is clear that this nation dominates SCP and reference impact. Table 7 identifies the top 16 nations that account for at least 1% of all literature submissions.

Table 7 Prominent Nations in Decision Making Education, productivity, and influence of scientists' research.

| Countries | SCP | SCP% | TC | Average Citation | TC% |
|---|---|---|---|---|---|
| USA | 1088 | 31.2 | 7019 | 19.8 | 41.5 |
| China | 689 | 19.8 | 836 | 4.8 | 4.8 |
| Indonesia | 178 | 8.95 | 58 | 3.9 | 0.39 |
| UK | 126 | 3.5 | 1149 | 28.9 | 6.9 |
| India | 86 | 2.9 | 298 | 12.9 | 1.9 |
| Australia | 8177 | 2.3 | 798 | 35.9 | 4.8 |
| Canada | 72 | 2.2 | 225 | 31.9 | 1.1 |
| Spain | 67 | 2.0 | 39 | 14.5 | 1.2 |
| Brazil | 65 | 1.9 | 28 | 1.9 | 0.3 |
| Protugal | 58 | 1.6 | 36 | 3.8 | 0.3 |
| South Africa | 56 | 1.6 | 743 | 9.9 | 1.8 |
| Malasiya | 54 | 1.2 | 29 | 4.8 | 1.4 |
| France | 34 | 1.6 | 189 | 18.9 | 0.6 |
| Italy | 34 | 1.0 | 29 | 4.5 | 0.9 |
| Greece | 34 | 1.2 | 48 | 9.4 | 0.4 |

## IV. CONCLUSION

We selected activities to assess ChatGPT's capabilities that would be categorized as having varying degrees of complexity for potential researchers (basic vs. sophisticated analysis methodologies). This gave us the opportunity to demonstrate that ChatGPT's performance is determined by the availability of training materials rather than the task's complexity. Therefore, in order to have a better understanding of the potential role that GPT-based tools may play in future study procedures, the data must be organized. First, as shown by our example, ChatGPT-3.5 may be a helpful research tool, but for best results, human participation and knowledge are required. This restricts how the free tools may be used for academic work. Either prompt crafting or sophisticated abilities in their area of interest—in our example, programming and statistics—are required of the user. We anticipate that both will typically be required to provide satisfactory results.

Significant advancements in GenAI research in the context of teaching chemistry are presented in this article. As mentioned, ChatGPT, Gemini, and Copilot produced adequate results for idea definition.

The scientific developments and evolutionary tendencies in DSC education during the last 25 years (2000–2022) were examined in this study.To fully investigate the subject, the writers created a number of study goals. We examined the effects of growth and citations, assessed the text analytics, thematic structure, and topic dynamics, and determined the changes over time.Using word frequency (f) or co-occurrence of themes, the R-Bibliometrix tool was used to analyze the text and organize the research keywords into three categories: the most popular subjects (f >= 10), developing research themes (10 > f >= 5), and the least investigated topics (f < 5). Ninety-seven percent of the keywords were found in the least common co-occurrence of terms, suggesting the study subjects that drew the least attention as areas to be investigated further (Figure 5).

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Emerging research topics accounted for 2.1%. These study areas include "business analytics," "online instruction," and "online learning resources." Figure 4 provides a complete list. "Artificial intelligence," "decision support systems," "pedagogical approaches," and "e-learning" comprise the most common category, which accounted for 1.1% of the total (Figure 2).One of the others is the use of decision scientists in the teaching of operations management and supply chain leadership. The thematic dynamics demonstrate how publications pertaining to various research areas have been consistent throughout the study's time frame (2000–2022).

Notwithstanding the compelling and convincing proof that GenAI provides DSC education, there are significant worries about its possible detrimental effects on academic integrity violations, unethical usage, data privacy and security, and other issues. Institutions of higher learning are under pressure to provide regulations on the use of GenAI in academics learning, research, instruction, and artistic endeavours.To checkmate the possible misuse, policy adoption may be a necessary but insufficient answer.We suggest putting AI automated detection systems into place and combining them to solve some of the issues with GenAI adoption.

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