



Educational frontiers with ChatGPT: a social network analysis of influential tweets

Fronteras educativas con ChatGPT: un análisis de redes sociales de tuits influyentes

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Abstract

The unprecedented adoption of OpenAI's ChatGPT, marked by reaching 100 million daily users in early 2023, highlights the growing interest in AI for educational improvement. This research aims to analyze the initial public reception and educational impacts of ChatGPT, using social network analysis of the 100 most influential tweets. Using the ForceAtlas2 algorithm and thematic content analysis, the study explores the appeal of ChatGPT and its prospects as an educational tool. The findings underscore ChatGPT's potential to revolutionize teaching methods, facilitate personalized learning, and bridge gaps in access to quality education. In addition, the analysis sheds light on ChatGPT's role in promoting critical thinking and interactive learning, its utility in creating educational content, and its ability to enhance teacher-student interactions. These findings point to a shift toward AI-enhanced education and argue for the integration of ChatGPT and similar technologies into learning environments. The discussion argues for empirical research on the educational impact of ChatGPT and urges a cautious approach to its adoption. It highlights the need for frameworks that harness the power of ChatGPT while addressing ethical and practical challenges. Finally, this study describes the initial reception of ChatGPT and highlights its transformative potential in education. It calls for strategic AI integration to optimize educational processes, and emphasizes the importance of continued research to navigate the evolving role of AI in learning.

Keywords: AI, ChatGPT, OpenAI, SNA, tweets, education.

Resumen

El uso sin precedentes de ChatGPT de OpenAI que alcanzó 100 millones de usuarios diarios a principios de 2023 es una muestra del creciente interés en la IA para la mejora educativa. Esta investigación pretende analizar la recepción pública inicial y las implicaciones educativas de ChatGPT, utilizando el análisis de redes sociales de los 100 tuits más influyentes. Mediante el algoritmo ForceAtlas2 y el análisis de contenido temático, el estudio explora el atractivo de ChatGPT y sus perspectivas como herramienta educativa. Los resultados subrayan el potencial de ChatGPT para revolucionar los métodos de enseñanza, facilitar el aprendizaje personalizado y reducir las brechas en el acceso a una educación de calidad. Además, el análisis informa sobre el papel de ChatGPT en la promoción del pensamiento crítico y el aprendizaje interactivo, su utilidad en la creación de contenidos educativos y su capacidad para mejorar las interacciones entre profesores y alumnos. Estas conclusiones apuntan a un cambio hacia una educación mejorada por la IA y abogan por la integración de ChatGPT y tecnologías similares en los entornos de aprendizaje. El debate aboga por la investigación empírica sobre el impacto educativo de ChatGPT e insta a adoptar un enfoque cauteloso en su adopción. Destaca la necesidad de marcos que aprovechen el poder de ChatGPT al tiempo que abordan los retos éticos y prácticos. Por último, este estudio describe la acogida inicial de ChatGPT y destaca su potencial transformador en la educación. Hace un llamamiento a la integración estratégica de la IA para optimizar los procesos educativos y subraya la importancia de seguir investigando para navegar por el papel evolutivo de la IA en el aprendizaje.

Palabras clave: IA, ChatGPT, OpenAI, SNA, tuits, educación.

1. Introduction

The development of artificial intelligence applications and the wide range of applications of the products they produce in many fields is one of the most important reasons why the new developments in this field are eagerly followed by users. Following the launch of the GPT-3 natural language processing model, which caused a great sensation with its features in 2020, OpenAI company launched the ChatGPT chat bot in November 2022. The results obtained from the use of ChatGPT have led to the beginning of a revolutionary period in artificial intelligence. Developed using the GPT-3.5 language model, an improved version of GPT-3, ChatGPT is the result of OpenAI's ongoing work on increasingly secure and useful artificial intelligence systems (OpenAI, 2023). The ability of ChatGPT to perceive texts written by humans to a good extent and to generate text that is indistinguishable from a text created by a human using its natural language processing ability has contributed to its popularity. In March 2023, the GPT 4 is available as final version. GPT 4 also accepts visual inputs.

After its launch, ChatGPT attracted more than one millions of users within just one-week, surpassing adoption rates of other popular online platforms such as Netflix, Facebook, and Instagram (Sier, 2022). In particular, discussions surrounding the current state of artificial intelligence technology were sparked for days as individuals shared on social media the texts generated on ChatGPT. The responses provided by ChatGPT to users' texts were shared on social media and used to discuss the evolution of artificial intelligence from the past to the present, as well as possible future scenarios. As one possible scenario for the future, Grant and Metz (2022) suggest that large language models (LLMs) like ChatGPT could serve as inspiration for the next generation of search engines capable of generating detailed and informative answers to complex user questions.

The fact that ChatGPT shows non-existent sources and provides incomplete and inaccurate information has been one of the most debated topics. For example, van Dis et al. (2023) cited the case where ChatGPT provided a general and non-research-based answer to the question asked by depression patients about the recurrence rate of their illness after treatment. One of the main factors

leading to this situation is the lack of content taught to ChatGPT that covers the question asked. Texts containing such misinformation resulting from the use of ChatGPT can provide false references for newly created texts. Neutrality and ethical values are among the most important qualities in texts based on research. One of the most important problems of significant LLMs such as ChatGPT from the perspective of researchers is that they do not have a transparent structure accessible to everyone (van Dis et al., 2023). This situation is contrary to the movement towards transparency and open science, as it prevents technology companies from hiding the internal workings of chat-based artificial intelligence and can make it difficult to reveal the source or gaps in information of chatbots (Rudin, 2019).

In educational settings, ChatGPT can assist in a number of ways, including designing assessments, producing essays, and translating languages. It can also be used to pose and answer a variety of questions, summarize texts, and interact with it in a manner similar to that of peers (Sok, 2023). As there are a number of innovative features offered by ChatGPT, it is an advantage for teachers to improve pedagogical practices by designing and integrating interactive classroom activities (Sok & Heng, 2023). The chat format of the platform also renders it interactive and accessible to individuals with varying degrees of technical expertise (Adeshola & Adepoju, 2023). The integration of AI-powered chatbots, such as ChatGPT, has the potential to revolutionize education by providing personalized and interactive learning experiences (Woodland, 2023). These chatbots, such as Google's Bard and OpenAI's ChatGPT, can provide dynamic conversations, instant feedback, and personalized learning materials that cater to individual needs and learning styles (Firat, 2023a). They increase learner engagement and motivation, enable continuous learning beyond the traditional classroom, and empower students to explore different subjects and expand their knowledge (Grassini, 2023). In addition, these AI technologies serve as valuable tools for educators, automating administrative tasks, generating instructional materials, and providing personalized feedback to students (Adıgüzel, et al., 2023). By harnessing the power of AI chatbots, educators can individualize their teaching approach, adapt to diverse student needs, and create more engaging learning environments

(Lozano & Blanco Fontao, 2023). However, concerns have been raised about the potential reduction in analytical skills and the need for critical evaluation of the chatbot's output (Currie & Barry, 2023). Overall, the integration of AI-powered chatbots has the potential to transform education by enhancing the learning experience and optimizing instruction.

Social media platforms have become indispensable communication networks where local or global prominent events are discussed and followed to determine the agenda. As a type of digital communication, various digital activism phenomena have emerged on social media using hashtags (#), and social media users have started a kind of digital social movement by showing their attitude towards whether or not to participate in the issue that stands out in a specific event, such as on X (previously Twitter) with the use of hashtags (#) (Yogatama et al., 2022).

1.1 Social Network Analysis and X (previously Twitter)

Social networks are one of the most important communication tools in today's digital world (Valencia-Ortiz, et al., 2023). Social media tools, which enable millions of people around the world to communicate with each other through shared visual and textual content, are among the most important data production platforms. Various techniques have been developed to analyze opinions about a product, predict election results, and examine how fake news spreads through social networks (Camacho et al., 2021). One of the most prominent techniques is social network analysis, which is used to map and measure formal or informal relationships, focusing on the structure of social relationships and the flow of information that connects interacting units. It aims to understand what facilitates or hinders the flow of information, who knows whom, the type of information and the communication channels (Serrat, 2017). Social network analysis method fits this research, which aims to identify the initial public reception and educational impacts of ChatGPT.

When examining the literature, many studies focus on X, one of the most important microblogging sites (Battisti et al., 2022). Microblogs allow users to share small content pieces such as short sentences, instant photos, or video links, enabling rapid

and intensive content sharing among users (Kaplan & Haenlein, 2011). The user capacity of X, as well as the structure and volume of the generated content, are the main reasons why it is frequently used by researchers who want to conduct social network analysis. ChatGPT is a highly effective tool for natural language processing (NLP) tasks. Its capabilities are being increasingly recognized by programmers and researchers, who are exploring its potential for creative applications in their work (Barari & Kumar, 2023). Therefore, in this study, we used the X platform to determine the first impressions, impact, and potential implications for education of ChatGPT, an innovative and rapidly expanding AI technology.

Various studies can be found in many different areas regarding social network analysis conducted with X data such as predicting election results (Grover et al., 2019), sentiment analysis (Alharbi & de Doncker, 2019), the finance sector (Battisti et al., 2022), tourism (Lu & Zheng, 2021), and education (Carpenter et al., 2020) to identify changes in these fields. When examining the characteristics of the X network, Kwak et al. (2010) found that most users use X to discuss their daily activities or their opinions on current issues. Compared to other social media tools, X is closely related to hashtag movements, social movements, and various forms of social campaigns (Li et al., 2021).

1.2 Related Studies

In line with the rapid popularization of ChatGPT, the academic literature on artificial intelligence tool is also expanding rapidly. The reasons for the high interest in ChatGPT have been attracting the attention of researchers since its public launch. As ChatGPT is still a new tool, academic publications on the tool have been limited. Most of these publications are in preprint type. The foci of the publications can be classified into the two themes as ChatGPT's benefits and ChatGPT's usage areas.

In the related literature there are some studies emphasizing the benefits of ChatGPT. For Cotton et al. (2023), one of the main advantages of ChatGPT's AI model is providing a platform for asynchronous communication. This feature can be used as an essential solution to prevent learners from feeling isolated in open and distance learning. Moreover, this feature enables students to send questions and

discuss topics without the need for simultaneous presence, resulting in increased student participation and collaboration (Li & Xing, 2021). Another advantage of ChatGPT is that it can facilitate collaboration among students. For example, ChatGPT that allow students to work together on projects and assignments can be used to create student groups (Lewis, 2022). Additionally, ChatGPT can be used to enable remote learning for learners who cannot attend classes for various reasons. ChatGPT also has the potential to be used for various purposes in education, such as support services, material production, measurement, and evaluation (Firat, 2023a).

The second theme that the literature focuses on is ChatGPT's areas of use, which is more relevant to this research. Haque et al. (2022) conducted a social network analysis using 10,732 X data to determine the topics surrounding ChatGPT and found that the contents can be classified under nine main headings. Through their research on X data and early adopters of ChatGPT, they identified several topics, including Q&A testing, chatbot intelligence, implications for search engines, future career and opportunities, impact on business development, implications for search engines, and impact on educational aspects. Similarly, Taecharungroj (2023) conducted a study on tweets related to ChatGPT from November 30 to December 31, 2022, and found that news, technology, reaction, creative writing, essay writing, prompt writing, code writing, answering questions, impacting tech, and impacting humans were the predominant topics.

A review of the related literature shows that there is a focus on predictions based on individual experiences and potential uses according to the capabilities of the tool rather than data-based insights. There are also studies (Haque et al., 2022; Taecharungroj, 2023) that have analyzed social

network posts related to ChatGPT. However, these studies are limited to topic analysis, descriptive classification and content analysis. For this reason, it is considered that there is a need for social network analysis research using valid and reliable layout Algorithms such as ForceAtlas. Thus, not only the topics will be reached, but the network structure between these topics will also be identified.

1.3 Research Purpose

The goal of this research is to explore the initial user perceptions and the underlying factors that led to the remarkable emergence of interest in ChatGPT. This will be accomplished through a social network analysis of the 100 most influential tweets about ChatGPT, collected from January 26 to February 1, 2023. By examining these interactions, this study aims to uncover users' reactions, expectations, and views on artificial intelligence. Such insights are expected to shed light on the various applications and implications of ChatGPT in different domains.

2. Methodology

The research employed social network analysis as a method, and data collection and analysis processes were conducted through the SocioViz platform. The data were collected two months after the emergence of ChatGPT because more realistic opinions about a new technology can mature only after a while. The 100 most popular tweets containing the keyword "ChatGPT" posted between January 26 and February 1, 2023, were subjected to social network analysis. The network map of the most influential users is provided in Figure 1.

Figure 1. Network of most influential users

As seen in Figure 1, there is no complex network structure among the users who posted popular ChatGPT tweets, and only two clusters are observed. The magenta-colored cluster is centered around the user @shifortech, who was found to mention other users in his tweet, highlighting the potential danger of ChatGPT. In the red, orange, and green-colored cluster, it was determined that three users retweeted a tweet containing the content “8 AI tools to save you 100s of hours of manual work” that mentions nine users.

The forceAtlas2 Layout Algorithm was used in the social network analysis of X posts. ForceAtlas2 is a continuous graph force-directed layout algorithm for network visualization (Jacomy et al., 2014). In ForceAtlas2, nodes repel each other like charged particles, while edges pull the nodes, they are connected to like springs. These forces create a movement towards a balanced state in a network structure. Therefore, the position of a node depends on its relationship with other nodes. Consequently, the position of a node cannot be interpreted in isolation; instead, the coherence of node groups is interpreted. This structure facilitates social network analysis.

Nodes that form a close community in the social network can be evaluated and thematized together. Noack (2009) demonstrated that the proximity between nodes represents communities, while Newman (2004) revealed that actors in a network have more relationships within the community than outside it. The essence of the algorithm is to convert structural closeness into visual closeness, making the analysis of social networks easier. Two important settings used in the adjustment of the forceAtlas2 Layout Algorithm are given below.

- *Gravity*: This setting prevents components (islands) that are disconnected from each other from moving away from each other. It positions the nodes in the center of the network. Its main purpose is to compensate for the repulsion of nodes moving away from the center and to keep the network together.
- *Scaling (Constant)*: This setting adjusts the gravitational and repulsive forces. It is used to reduce or increase the size of the graph.

In this study, the default values of gravitational force (-2000), central gravity (0.3), and spring constant (0.04) were used in the social network analysis. Finally, the Prevent Overlapping setting was enabled to reduce overlapping and enhance readability and aesthetic appearance.

To name the clusters that form in social networks, we used the thematic content analysis technique. Thematic content analysis identifies patterns and concepts based on the similarities and differences in the examined content (top words or hashtags). This technique provides an analytical framework for uncovering hidden structures within the whole. Thomas and Harden (2008) identified three basic steps in this analysis: (1) coding the data line by line, (2) organizing the codes to develop descriptive themes, and (3) integrating the themes to form comprehensive

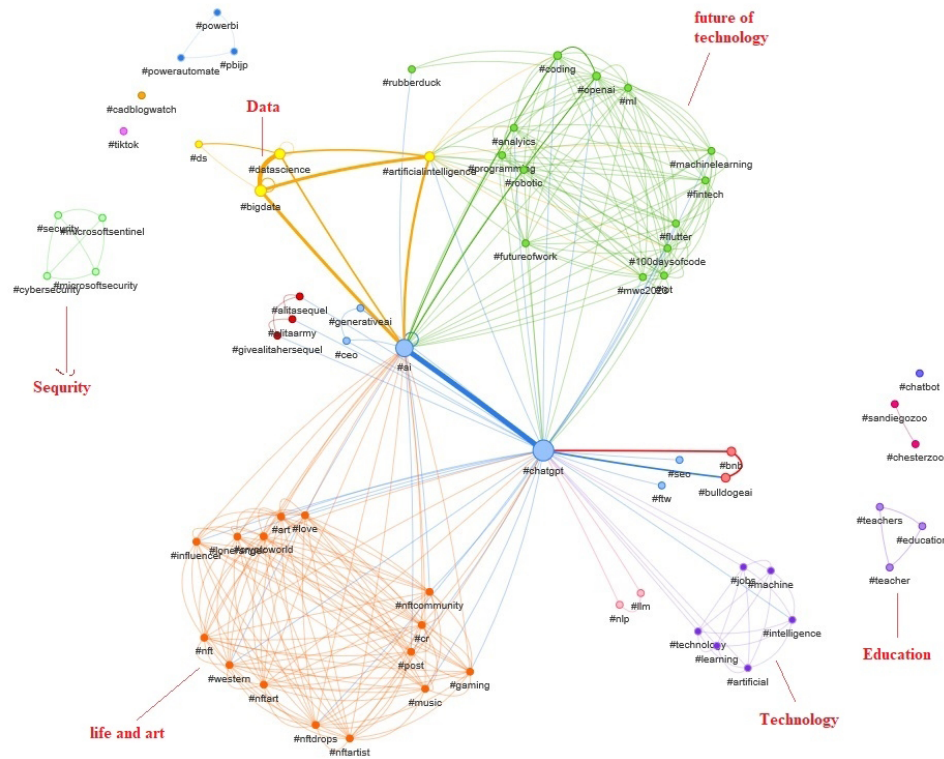
themes. In this research, the steps recommended by Thomas and Harden (2008) were followed.

The COPE (Committee on Publication Ethics) has been followed in this research. The main ethical considerations in this research were protection of the participants' privacy. Tweets data have been anonymized with the themes and keywords. Participants' names were not used in the text of the article.

3. Results

The prominent hashtags in the analyzed posts were identified as #chatgpt (17), #ai (13), #bigdata (6), #datascience (5), and #artificialintelligence (4). The network formed by the hashtags used in 100 posts is presented in Figure 2 below.

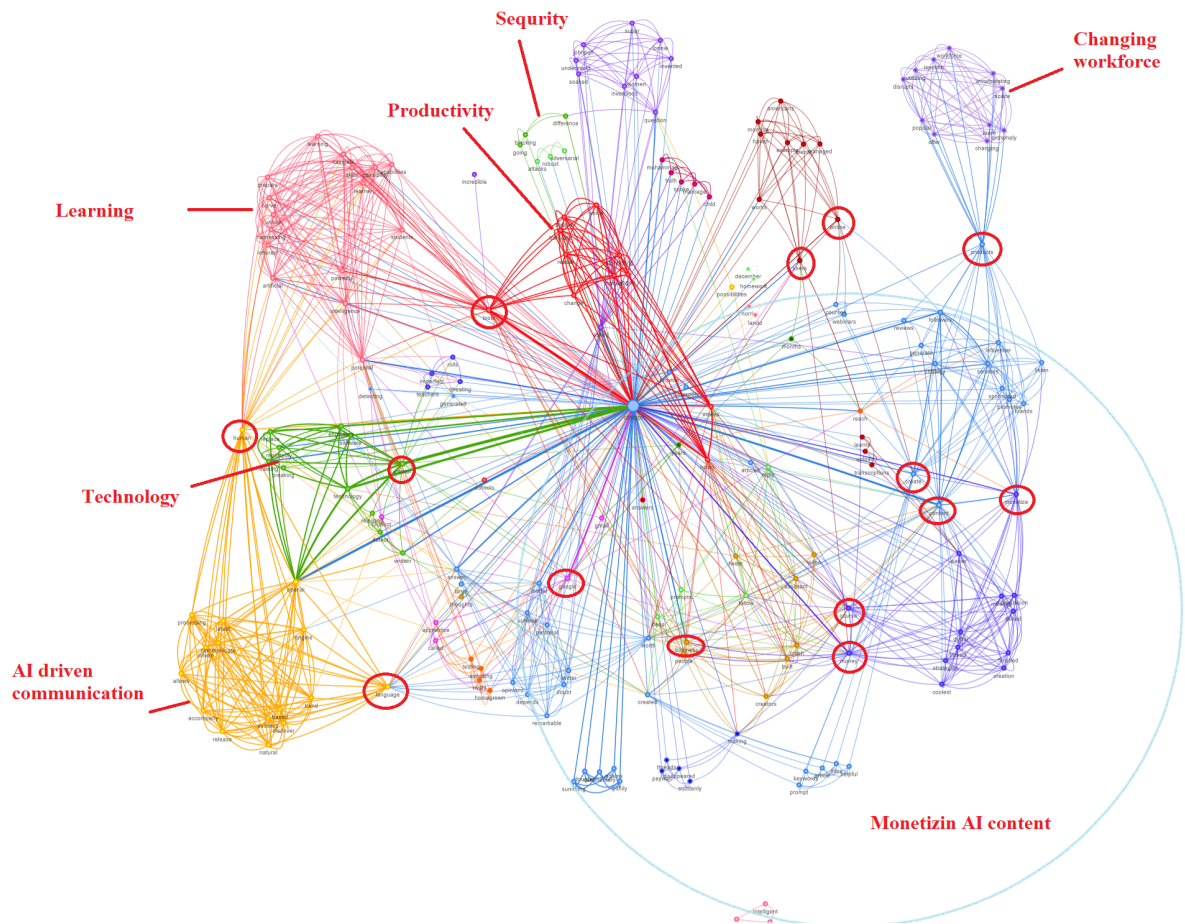
Figure 2. Network map of hashtags on ChatGPT



Six clusters were distinguished in the hashtag network. We analyzed the hashtags gathered in these clusters using thematic content analysis. The themes we identified in order of importance were life and art, future technology, data, technology, security, and education.

The top words used in the tweets were chatgpt (89), openai (10), content (10), tools (9), creator

(9), technology (7), human (6), google (6), language (5), and products (5). We inferred from the top words that ChatGPT is primarily perceived as a content creation tool. The network map of the top 100 keywords used in the 100 tweets is presented in Figure 3 below.

Figure 4. Network map of top 200 words

The network structure of the top 200 words mentioned in tweets about ChatGPT confirmed the findings obtained from the analysis of the top 100 words. In addition, we identified two new themes related to the commercial aspect of ChatGPT. The first one is the changing workforce theme, which is quite clearly clustered. The second one is the monetizing ai content theme, which has an unstable cluster structure and consists of multiple sub-themes such as earning easy money from content, new marketing techniques, increasing followers of influencers, emergence of new business areas, alternatives to Google, and smart assistants. However, when the connecting words in the green circle are examined, concepts such as money, monetize, business, Google, create, content, and course are found. Therefore, we decided to combine them under the monetizing ai content main theme. We also identified strong connecting nodes in the rest of the network. The most remarkable ones are the human, tools, products, and language nodes. The human

node strongly connects the ai driven communication and learning clusters, while the tools node links the productivity and learning themes. The language node serves as the connecting node between monetizing ai content and ai driven communication, while the products node connects monetizing ai content and changing workforce.

4. Discussion and conclusions

The findings of this study, which aimed to demonstrate the impact of ChatGPT on X users, indicate that ChatGPT can be a versatile model that can be applied to various tasks for different purposes. In the study, we analyzed the most popular 100 tweets between November 30, 2022 and February 1, 2023 in which ChatGPT was used. We found that the tweets were grouped under six different hashtag themes: life and art, future technology, data, technology, security, and education. One of the most important

findings from the hashtag analysis is related to how ChatGPT is perceived. The obtained themes showed that ChatGPT is perceived as a content creation tool. This perception seems to be in line with the structural nature of the Generative Pre-trained Transformer (GPT) model. In the top 100-word network, the themes of learning, AI-driven communication, productivity, and technology stood out according to their weights. It is noteworthy that technology and learning-education themes were present in both analyses. This finding emphasizes the potential of ChatGPT to be used for learning and education purposes as an innovative technology.

In the literature, it is possible to come across many studies proving that artificial intelligence has played a leading role in the emergence of technological innovations in many areas over the past few years. One of the areas where artificial intelligence has been applied and has had a great impact is education. In particular, integrating artificial intelligence into various applications such as mobile devices, robots, and games to facilitate education and learning has become widespread (Chen et al., 2022). Artificial intelligence enables personalized and adaptive teaching methods, which provide special support and increase awareness of knowledge gaps, to be more effective and efficient (Guan et al., 2020). The use of language models like ChatGPT in education appears as a potential area of interest due to their rich and wide range of applications (Firat, 2023a). Using these models, it will be possible to create personalized and effective learning experiences for individuals at every level of education, in line with each individual's unique learning preferences, abilities, and needs (Kasneci, 2023). Rudolph et al. (2023) pointed out that using artificial intelligence applications such as ChatGPT in time-consuming tasks such as evaluation is an important opportunity for improving teacher skills. Teachers can benefit from ChatGPT to develop their teaching strategies and allocate more time to individual students (Firat, 2023a).

In the network analysis of the top 200 words, two main themes were identified related to the commercial aspect of ChatGPT: changing workforce and monetizing AI content. These findings are consistent with existing literature. The “impact on business development changing” theme of Haque et al. (2002) and the “impacting humans” theme of Taecharungraj (2023) align with our themes of

changing workforce and monetizing AI content. The ability of AI to process large amounts of data at low cost demonstrates its potential significance in marketing (Huang & Rust, 2021). Furthermore, the “productivity” theme can be said to overlap with the “Entertainment and Exercising Creativity” section of Haque et al. (2022). ChatGPT's ability to generate various types of content, such as essays, prompts, code, and interviews, in a way that is similar to what a human could produce, is believed to play a significant role in the emergence of the “creativity” and “productivity” themes.

Since its inception, ChatGPT has experienced a significant rise in popularity, with a plethora of opinions emerging regarding its diverse applications. In this study, we rigorously analyzed the top 100 X posts pertaining to ChatGPT, which debuted in November 2022, employing social network analysis. The analysis was conducted on SocioViz, utilizing the ForceAtlas2 algorithm. Through our exhaustive analysis, we identified nine overarching themes: life and art, future technology, data, security, education and learning, AI-mediated communication, productivity, workforce transformation, and monetization of AI content.

Our research findings have yielded several salient insights. We executed a thematic content analysis on the hashtags present in the social network analysis, and discerned themes including life and art, future technology, data, security, and education. Additionally, an analysis of the most prominent keywords led to the identification of learning, AI-mediated communication, productivity, and technology. Notably, both hashtag and keyword analyses highlighted the prominence of technology, coupled with learning and education. A noteworthy observation was the strong interlinkage between the human node in AI-mediated communication and the education-learning cluster. The tools node also exhibited an association between productivity and education-learning themes. These observations underscore ChatGPT's burgeoning interest within educational domains, primarily attributed to its anthropomorphic AI-mediated communication capabilities. Moreover, ChatGPT is perceived as an instrumental tool for enhancing productivity within educational settings.

In an extension to the analysis with the top 100 keywords, we expanded our scope to encompass

the top 200 keywords. This enabled us to unearth two additional themes through social network and thematic analysis - workforce transformation and monetization of AI content. The keyword “products” served as the nexus between these two themes. These insights suggest that ChatGPT, as one of the early triumphant exemplars of artificial intelligence, has considerable influence on production-centric business processes. The analyzed posts insinuate the potential of AI in transforming the business landscape. Predominantly, there is a consensus on the efficacy of AI in expediting content production and revisions. Supporting sub-themes encompass streamlined monetization through content, novel marketing strategies, bolstering influencer followings, the advent of new business verticals, potential alternatives to established platforms such as Google, and the emergence of intelligent assistants.

4.1 Limitations and Suggestions

This research is circumscribed by the Social Network Analysis (SNA) of the top 100 tweets encompassing ChatGPT within a narrow timeframe from January 26 to February 1, 2023. Given the accelerated trajectory of ChatGPT’s popularity, the dataset represents a snapshot, and the volume of tweets and discussions has since proliferated. A more exhaustive SNA could be achieved through the aggregation and analysis of an extended dataset, spanning a more extensive time frame. Finally, based on the findings of this research, it is possible to list some suggestions:

- *Integration of AI in Education:* Our findings underscore the significance of integrating AI into educational platforms. The expansion of integration avenues, such as ChatGPT’s Learning Management System (LMS) integration as highlighted by Firat (2023b), will bolster the employment of AI for educational objectives. AI has the potential to alter individual learning habits and behaviors, with ChatGPT being particularly beneficial for students in areas like homework assistance. Hence, it is imperative for educational institutions to make the necessary preparations for incorporating AI into curricular programs and activities. For instance, implementing GPT Output Detectors

can be an effective measure to identify content generated through AI.

- *Navigating Workforce Transformation and AI Monetization:* The themes of workforce transformation and monetization of AI content emerged prominently in our analysis. This suggests that AI, and ChatGPT in particular, exerts a profound influence on the business landscape. Given the rapid pace of AI adoption, it is paramount for industries to swiftly adapt to these changes. Experimental studies aimed at understanding the actual impact and validating the predictions concerning ChatGPT will be instrumental.
- *Addressing the Transition to Paid Models:* As of May 2023, ChatGPT’s transition from a free model to a paid model, particularly after achieving an excess of 100 million daily users, is noteworthy. This shift may affect accessibility and user dynamics. It is crucial to monitor and assess the impact of this transition on user engagement and application in various domains.

References

- Adeshola, I. & Adepoju, A. P. (2023). The opportunities and challenges of ChatGPT in education. *Interactive Learning Environments*, 1-14. <https://doi.org/10.1080/10494820.2023.2253858>
- Adıgüzel, T., Kaya, M. H. & Cansu, F. K. (2023). Revolutionizing education with AI: Exploring the transformative potential of ChatGPT. *Contemporary Educational Technology*, <https://doi.org/10.30935/cedtech/13152>
- Alharbi, A. S. M. & de Doncker, E. (2019). Twitter sentiment analysis with a deep neural network: An enhanced approach using user behavioral information. *Cognitive Systems Research*, 54, 50-61. <https://doi.org/10.1016/j.cogsys.2018.10.001>
- Barari, A. & Kumar, A. (2023). What is ChatGPT? Best uses and limitations of the brand-new tool. *Emeritus Online Courses*. <https://emeritus.org/blog/ai-ml-what-is-chatgpt/>
- Battisti, E., Graziano, E. A. & Christofi, M. (2022). Equity crowdfunding platforms and social media: a Twitter analysis. *International Journal of Entrepreneurial Behavior & Research*, 28(5), 1206-1221. <https://doi.org/10.1108/IJEBR-01-2021-0081>
- Bian, J., Yoshigoe, K., Hicks, A., Yuan, J., He, Z., Xie, M., ... & Modave, F. (2016). Mining Twitter to assess

- the public perception of the “Internet of Things”. *PloS One*, 11(7), e0158450.
<https://doi.org/10.1371/journal.pone.0158450>
- Boyatzis, R.E. (1998). *Transforming qualitative information: thematic analysis and code development*. Sage, 1998.
- Camacho, D., Luzón, M. V. & Cambria, E. (2021). New research methods & algorithms in social network analysis. *Future Generation Computer Systems*, 114, 290-293.
<https://doi.org/10.1016/j.future.2020.08.006>
- Carpenter, J., Tani, T., Morrison, S. & Keane, J. (2020). Exploring the landscape of educator professional activity on Twitter: An analysis of 16 education-related Twitter hashtags. *Professional Development in Education*, 1-22.
<https://doi.org/10.1080/19415257.2020.1752287>
- Chen, X., Zou, D., Xie, H., Cheng, G. & Liu, C. (2022). Two decades of artificial intelligence in education. *Educational Technology & Society*, 25(1), 28-47. <https://www.jstor.org/stable/48647028>
- Cotton, D. R., Cotton, P. A. & Shipway, J. R. (2023). *Chatting and Cheating. Ensuring academic integrity in the era of ChatGPT*.
<https://doi.org/10.1080/14703297.2023.2190148>
- Currie, G. & Barry, K. (2023). ChatGPT in nuclear medicine education. *Journal of Nuclear Medicine Technology*, 51(3), 247-254.
<https://doi.org/10.2967/jnmt.123.265844>
- Firat, M. (2023a). *How Chat GPT Can Transform Autodidactic Experiences and Open Education?*.
<https://doi.org/10.31219/osf.io/9ge8m>
- Firat, M. (2023b). Integrating AI Applications into Learning Management Systems to Enhance e-Learning. *Instructional Technology and Lifelong Learning*, 4 (1), 1-14.
<https://doi.org/10.52911/ital.1244453>
- Grant, N. & Metz, C. (2022). A New Chat Bot Is a ‘Code Red’ for Google’s Search Business. *The New York Times*. <https://bit.ly/48QK0Xo>
- Grassini, S. (2023). Shaping the future of education: exploring the potential and consequences of AI and ChatGPT in educational settings. *Education Sciences*, 13(7), 692.
<https://doi.org/10.3390/educsci13070692>
- Grover, P., Kar, A. K., Dwivedi, Y. K. & Janssen, M. (2019). Polarization and acculturation in US Election 2016 outcomes—Can twitter analytics predict changes in voting preferences. *Technological Forecasting and Social Change*, 145, 438-460.
<https://doi.org/10.1016/j.techfore.2018.09.009>
- Guan, C., Mou, J. & Jiang, Z. (2020). Artificial intelligence innovation in education: A Twenty-year data-driven historical analysis. *International Journal of Innovation Studies*, 4(4), 134-147.
<https://doi.org/10.1016/j.ijis.2020.09.001>
- Haque, M. U., Dharmadasa, I., Sworna, Z. T., Rajapakse, R. N. & Ahmad, H. (2022). “I think this is the most disruptive technology”: Exploring Sentiments of ChatGPT Early Adopters using Twitter Data. *arXiv preprint arXiv:2212.05856*.
<https://doi.org/10.48550/arXiv.2212.05856>
- Huang, M. H. & Rust, R. T. (2021). A strategic framework for artificial intelligence in marketing. *Journal of the Academy of Marketing Science*, 49, 30-50.
<https://doi.org/10.1007/s11747-020-00749-9>
- Jacomy, M., Venturini, T., Heymann, S., Bastian, M. (2014). ForceAtlas2, a Continuous Graph Layout Algorithm for Handy Network Visualization Designed for the Gephi Software. *PLoS ONE* 9(6), e98679.
<https://doi.org/10.1371/journal.pone.0098679>
- Kaplan, A. M. & Haenlein, M. (2011). The early bird catches the news: Nine things you should know about micro-blogging. *Business Horizons*, 54(2), 105-113.
<https://doi.org/10.1016/j.bushor.2010.09.004>
- Kasneci, E., Seßler, K., Küchemann, S., Bannert, M., Dementieva, D., Fischer, F., ... & Kasneci, G. (2023). ChatGPT for good? On opportunities and challenges of large language models for education. *Learning and Individual Differences*, 103, 102274.
<https://doi.org/10.1016/j.lindif.2023.102274>
- Kwak, H., Lee, C., Park, H. & Moon, S. (2010, April). What is Twitter, a social network or a news media?. In *Proceedings of the 19th international conference on World wide web* (pp. 591-600).
<https://doi.org/10.1145/1772690.1772751>
- Lozano, A. & Blanco Fontao C. (2023). Is the Education System Prepared for the Irruption of Artificial Intelligence? A Study on the Perceptions of Students of Primary Education Degree from a Dual Perspective: Current Pupils and Future Teachers. *Education Sciences*. 13(7), 733.
<https://doi.org/10.3390/educsci13070733>
- Lewis, A. (2022). “Multimodal large language models for inclusive collaboration learning tasks.” *Proceedings of the 2022 Conference of the North American Chapter of the Association for Computational Linguistics: Human Language Technologies: Student Research Workshop*, 202-210.
<https://doi.org/10.18653/v1/2022.naacl-srw.26>
- Li, C. & Xing, W. (2021). “Natural language generation using deep learning to support MOOC learners.” *International Journal of Artificial Intelligence in Education*, 31(2): 186-214.

- <https://doi.org/10.1007/s40593-020-00235-x>
- Li, M., Turki, N., Izaguirre, C. R., DeMahy, C., Thibodeaux, B. L. & Gage, T. (2021). Twitter as a tool for social movement: An analysis of feminist activism on social media communities. *Journal of Community Psychology*, 49(3), 854-868.
<https://doi.org/10.1002/jcop.22324>
- Lu, Y. & Zheng, Q. (2021). Twitter public sentiment dynamics on cruise tourism during the COVID-19 pandemic. *Current Issues in Tourism*, 24(7), 892-898.
<https://doi.org/10.1080/13683500.2020.1843607>
- Newman, M. E. (2004). Analysis of weighted networks. *Physical Review E*, 70(5), 056131.
<https://doi.org/10.1103/PhysRevE.70.056131>
- Noack, A. (2009). Modularity clustering is force-directed layout. *Physical Review E*, 79(2), 026102.
<https://doi.org/10.1103/PhysRevE.79.026102>
- OpenAI, (2023). *Chat GPT*. Retrieved from <https://openai.com/blog/chatgpt/> on 2 January 2023.
- Rudin, C. (2019). Stop explaining black box machine learning models for high stakes decisions and use interpretable models instead. *Nature machine intelligence*, 1(5), 206-215.
<https://doi.org/10.1038/s42256-019-0048-x>
- Rudolph, J., Tan, S. & Tan, S. (2023). ChatGPT: Bullshit spewer or the end of traditional assessments in higher education?. *Journal of Applied Learning and Teaching*, 6(1).
<https://doi.org/10.37074/jalt.2023.6.1.9>
- Serrat, O. (2017). Social network analysis. *Knowledge solutions: Tools, methods, and approaches to drive organizational performance*, 39-43.
https://doi.org/10.1007/978-981-10-0983-9_9
- Sier, J. (2022) *Chatgpt takes the internet by storm, bad poetry and all*. Accessed December 10, 2022.
<https://bit.ly/3luxpyn>
- Sok, S. (2023). Opinion: Benefits and risks of ChatGPT in education. *Cambodianess*.
<https://cambodianess.com/article/opinion-benefitsand-risks-of-chatgpt-in-education>
- Sok, S.& Heng, K. ChatGPT for Education and Research: A Review of Benefits and Risks (2023). Available at SSRN:
<https://ssrn.com/abstract=4378735> or <http://dx.doi.org/10.2139/ssrn.4378735>
- Taecharungroj, V. (2023). “What Can ChatGPT Do?” Analyzing Early Reactions to the Innovative AI Chatbot on Twitter. *Big Data and Cognitive Computing*, 7(1), 35.
<https://doi.org/10.3390/bdcc7010035>
- Thomas, J. & Harden, A. (2008). Methods for the thematic synthesis of qualitative research in systematic reviews. *BMC Medical Research Methodology*, 8(1), 1-10.
<https://doi.org/10.1186/1471-2288-8-45>
- Valencia-Ortiz, R., Garay-Ruiz, U. & Cabero-Almenara, J. (2023). Problematic use of online social networks: the case of Mexican students. *Alteridad*, 18(1), 23-33. <https://doi.org/10.17163/alt.v18n1.2023.02>
- van Dis, E. A., Bollen, J., Zuidema, W., van Rooij, R. & Bockting, C. L. (2023). ChatGPT: five priorities for research. *Nature*, 614(7947), 224-226.
<https://doi.org/10.1038/d41586-023-00288-7>
- Woodland, T. (2023). ChatGPT for Improving Medical Education: Proceed with Caution. *Mayo Clinic Proceedings: Digital Health*, 1(3), 294-295.
<https://doi.org/10.1016/j.mcpdig.2023.04.006>
- Yogatama, A., Sugiarto, I. & Gumelar, A. B. (2022). Social Network Analysis of Citizen Initiated Vaccination Campaigns on Twitter. In *International Conference on Community Empowerment and Engagement (ICCEE 2021)* (pp. 122-132). Atlantis Press.
<https://doi.org/10.2991/assehr.k.220501.014>
- Zhuo, T. Y., Huang, Y., Chen, C. & Xing, Z. (2023). Exploring ai ethics of ChatGPT: A diagnostic analysis. *arXiv preprint arXiv:2301.12867*.
<https://doi.org/10.48550/arXiv.2301.12867>