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**The Impact of New It&C Technologies on Academic Performance: An Analysis of How Web 2.0 and Large Language Models Affect the Educational and Research Processes in Universities**

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### **Abstract**

*Digital technology is an integral part of the research and educational processes in universities. Hybrid education has already overtaken the traditional model used prior to 2020. Virtual classes have evolved into a space where the educational process begun in physical classes can be continued and expanded. The use of digital educational platforms such as Moodle or Google Classroom is on the rise and facilitate the use of assessment automation on an ever-increasing scale. Evaluation methods must be remodeled in such a way that they are less vulnerable to artificial intelligence programs such as ChatGPT. The emergence of large language models, as well as other aspects of technological evolution, are putting increasing pressure on the academic world, forcing it to become significantly more adaptable and resilient. The intense use of the IT&C technologies in the education sector began with the introduction of web 2.0 tools. With the pandemic, societies faced a revolution in the IT&C sector. Websites and applications that make use of user-generated content, the increased network connectivity, and enhanced communication channels started becoming tools used in education to enhance the quality of the entire process. The Universities had to adapt then just like they have to now, even though specific challenges may be different. This paper presents a comparison of how Web 2.0 and the evolution of large language models affected the educational and research processes in universities and how everything adapted to their specific reality.*

**Keywords:** education, digitalisation, large language models.

**JEL Classification:** I21, I23, O33.

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## **1. Introduction**

Digital technology has become an integral part of research and educational processes in universities, with hybrid education growing more and more (Xie et al., 2020). The COVID-19 pandemic has accelerated the adoption of virtual classes and digital educational platforms, such as Moodle and Google Classroom (Chinie et al., 2022), which have facilitated the continuation and expansion of the educational process (Ionescu et al., 2020). However, the increasing use of digital technologies, including large language models and artificial intelligence, has posed challenges to the academic world, necessitating adaptability and resilience (Yan et al., 2023).

The emergence of Web 2.0 tools and the evolution of large language models have significantly impacted the educational and research processes in universities. Web 2.0 tools, characterised by user-generated content and enhanced communication channels (Jones, Iredale, 2009), have been utilised to enhance the quality of the educational process (Usluel, Mazman, 2009). These tools have facilitated collaboration, knowledge sharing, and active participation among students, teachers, and researchers (Dahlan et al., 2010). On the other hand, the evolution of large language models, such as ChatGPT, has raised concerns about the vulnerability of evaluation methods to artificial intelligence programs (Yu, 2023).

The COVID-19 pandemic has further highlighted the importance of digital technologies in education. Online education has provided unprecedented access to learning opportunities and has the potential to democratise and evolve the teaching act (Gorina et al., 2023). However, challenges such as technological constraints, lack of engagement, or a sense of belonging need to be addressed to ensure the success of online education (Peacock et al., 2020). The effective usage of digital communication platforms, including social media and digital PR models (Busu et al., 2020), has played a crucial role in maintaining the sustainability of universities during the crisis (Ayman et al., 2020).

The paper analyses the similarity between the launch of ChatGPT and the development of digitalisation during the COVID-19 period from a bibliometric point of view. The emergence of large language models, such as ChatGPT, has revolutionised the way information is generated and processed (Usluel, Mazman, 2009). These models have the ability to generate human-like text and have been used in various applications, including chatbots, text generation, and sentiment analysis (Gómez Cano et al., 2023). The launch of ChatGPT represents a significant milestone in the field of natural language processing and artificial intelligence.

The COVID-19 pandemic has accelerated the adoption of digital technologies in various sectors, including healthcare, communication, and education (Petracca et al., 2020). The reliance on digital health technologies and the use of digital platforms to support mental health and provide resources to healthcare workers have become increasingly important during the pandemic (Mata-Greve et al., 2021). The integration of these technologies has transformed the educational and research processes in universities, enabling remote learning, collaboration, and access to information (Dima et al., 2020). These tools have facilitated collaboration, knowledge sharing, and active participation among students, teachers, and

researchers. On the other hand, the emergence of large language models, such as ChatGPT, has raised concerns about the vulnerability of evaluation methods in Higher Education Institutions.

## **2. Problem Statement**

The advent of Large Language Models (LLMs) represents a substantial milestone in contemporary research and education. These advanced artificial intelligence systems have not only transformed the way information is processed and disseminated but have also reshaped pedagogical practices and research methodologies. While their potential for catalysing a new era of digitalisation is considerable, the implications of such transformative technologies necessitate thorough investigation and understanding, which is why Chat GPT, for example, is a common discussion and research topic in the last period. However, this type of change is not entirely new to society. The COVID-19 pandemic served as a tipping point as well, pushing many public and private institutions to expedite their digital transformation strategies. This urgent shift introduced a range of challenges and opportunities, leaving institutions navigating uncharted territory in terms of implementing new digital tools and platforms, maintaining quality service delivery, and addressing issues of equity and access. Both of these quick transition periods were carefully analysed by the academic community, but there remains a question of “How different are they and what can we learn from their comparison?”

## **3. Aims of the Research**

The primary objective of this paper is to investigate the similarities and differences between the digital transformation necessitated by the COVID-19 pandemic and the introduction and utilisation of Large Language Models, such as ChatGPT, in the realm of research and education. This endeavour involved the following specific aims:

- **Historical Analysis:** To provide an in-depth analysis of the events that triggered the rapid digitalisation during the COVID-19 pandemic, highlighting the key challenges faced, the solutions adopted, and the lessons learned. Similarly, we aimed to trace the development and deployment of ChatGPT, focusing on its impact on research and education, and addressing the challenges and opportunities it presents. This was done through a thorough literature review.
- **Comparative Study:** To draw parallels and contrasts between the digital transformation during the COVID-19 period and the launch of ChatGPT, based on a Latent Dirichlet Allocation (LDA) analysis.
- **Impact Assessment:** To assess the short-term and long-term impacts of both the pandemic-induced digitalisation and the introduction of ChatGPT on research and education. This will involve the evaluation of the advantages and limitations of each in terms of improving research productivity, enhancing educational delivery, and shaping future trends.

Ultimately, the objective of this study is to use these insights to better understand the dynamics of digitalisation in the research and education sectors and to guide future policy and practice in the era of artificial intelligence.

#### **4. Research Methods**

**i. Data Collection:** The first step in this research involved data collection from two separate periods – the initial six months of the COVID-19 pandemic (the COVID-19 period) and the first six months after the launch of ChatGPT. Our data primarily consists of academic papers and reports published during these periods. We have amassed a number of 604 papers on Chat GPT and 979 papers on the COVID-19 period. For the Covid period, we focused on collecting articles that discuss digital transformation, particularly those that concentrate on education and research fields. In the case of ChatGPT, our focus will be on articles that evaluate, critique, or discuss the implications and applications of ChatGPT in the same sectors. The main source of analysed data was the arxiv database, which is a free distribution service and an open-access archive for over two million scholarly articles.

**ii. Data Preprocessing:** Following data collection, we preprocessed the data to prepare it for analysis. This process included steps such as removing stop words (e.g., 'the', 'a'), stemming (reducing words to their root form), and lemmatisation (ensuring the root word belongs to the language). We also converted the text to a machine-readable format and implement tokenisation, converting sentences into individual words or 'tokens'.

**iii. Topic Modeling Using Latent Dirichlet Allocation (LDA):** We employed Latent Dirichlet Allocation (LDA) to conduct topic modeling on the preprocessed data from both periods. LDA is a probabilistic topic model that assumes documents are a mixture of topics and that each word in the document is attributable to one of the document's topics. By analysing the distribution of topics and the frequency of words within those topics, we can identify the dominant topics in the research and discourse from each period. The model hyperparameters were chosen using a grid search methodology, with over 540 models trained for each period, optimising for coherence as a performance management measure.

**iv. Comparison of Topic Models:** When generating the topic models for the two periods, we compared them to identify similarities and differences in the dominant themes of the two periods. This will involve a careful review of the topic keywords, their distribution, and their representation within the documents.

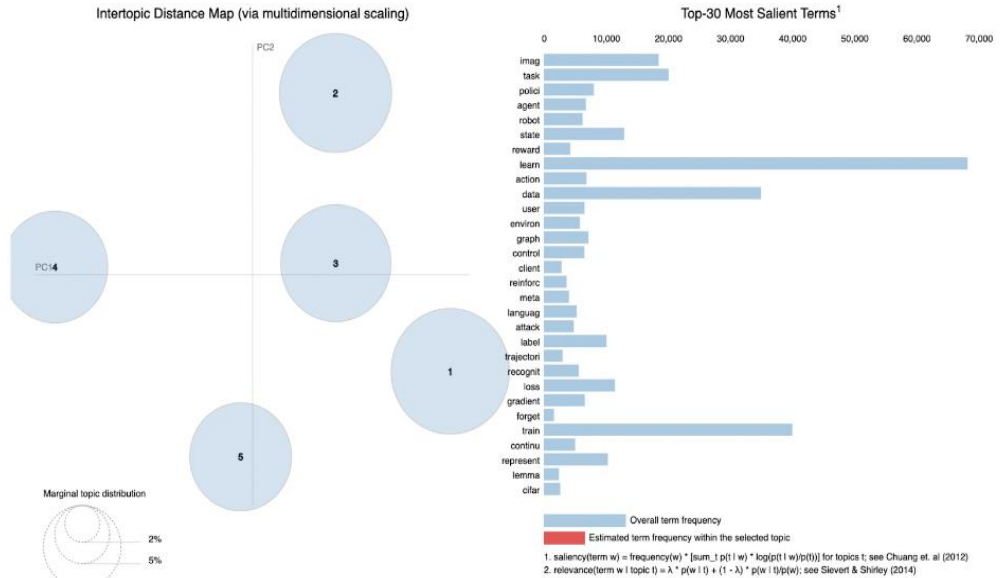
**v. Interpretation and Analysis:** Finally, we interpreted the results, placing them in the context of the broader digital transformation in research and education. This step involved analysing how the discourse evolved from the Covid period to the introduction of ChatGPT, noting the trends, shifts, and continuities.

The methodology outlined above provided a comparative analysis of the main topics discussed during the initial digitalisation period during the COVID-19 pandemic and the first six months after the ChatGPT launch.

## 5. Findings

For the COVID period, the best performing LDA model identified five topics inside the full text corpus.

**Figure 1. LDA Analysis – Covid Period Research**



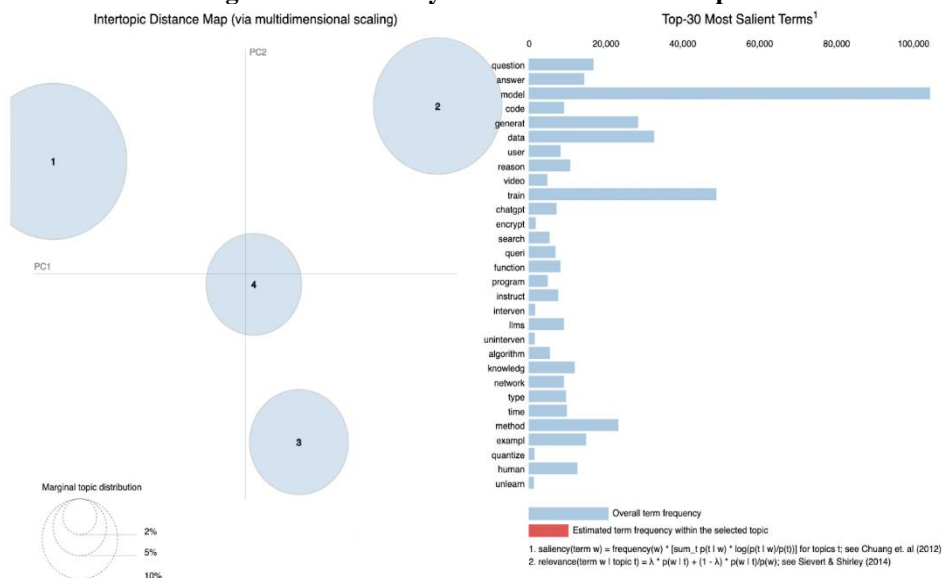
Source: Author’s own.

Topics 1, 3 and 5, each refer to different methodological approaches used to study the different types of data that were available during the COVID pandemic. Topic 1 can be titled as “Deep Learning Research”, containing terms such as “image, recognition, speech, natural, language, deep, model, vision, supervised, attention, text, etc.”. Topic 3 can be summarised as “Network Effects Research”, with the most salient terms such as “lemma, network, robustness, domain, sample, graph”. Topic 5 can be summarised as “Shallow Machine Learning Research” with the most salient terms being: “lemma, theorem, gradient, layers, task, learn, forget”.

The other two topics present in the LDA representation of the COVID 19 papers, are both referring to specific research conducted in the pandemic period. Topic 2 refers specifically to education and research in education, with the most salient terms being: “education, communication, online, surveys, students, participation”, while topic 4 refers to a broader topic, namely “Policy Making”, with the most salient terms being: “state, policy, uncertainty, learn, control, trajectory”.

For GPT, there were mainly four topics present inside the best model that was trained given the data.

**Figure 2. LDA Analysis – Chat GPT Launch period**



Source: Author’s own.

The first group can be characterised as “Quantitative Research done on ChatGPT” with the most salient terms being: “data, model, train, task, learn, text, encode, represent”, the second group can be characterised as “ChatGPT Response Evaluation”, with terms such as: “question, answer, human, performance, argument, evaluation”. The third group can be characterised as “ChatGPT impact in education”, with the most salient terms being: “education, student, learn, function, retract, refer, privacy”. The last group can be characterised as “The future of Large Language Models” with the most salient terms being: “quantum, cloud, computing, cryptography, particle”.

There are more or less obvious similarities and differences between the core topics identified for these two periods. First of all, we can see that in both periods, different types of quantitative research was being conducted. In the COVID period, all of the areas of statistical modeling were present, while in the ChatGPT period there seems to be a limitation of quantitative methods, that can be attributed to the lack of data and computing power that is needed to conduct research in the area of Large Language Models.

Second of all, the area of research and education was present in both of the studied periods, especially because of the choice of search terms that were used in data collection, but this area seems to be studied through different lenses. While in the COVID-19 period, the most salient terms contain “communication”, “online” and “survey”, in the GPT period, they contain “student”, “education” and “function”. The terms are linked with the most important areas of research conducted in the specific periods, namely the impact of online education in the educational processes

in the COVID-19 period and the impact of Large Language Models in the area of education for the ChatGPT period.

Last but not least, there were two topics that are highly specific to each of the studied periods. For the COVID-19 period, this was the topic of policy making, and for the ChatGPT period, this was the topic regarding the future of large language models, with specific topics such as quantum computing, cloud computing, cryptography, etc.

## 6. Conclusions

Based on the Latent Dirichlet Allocation (LDA) analysis conducted on research produced during the first six months of the COVID-19 pandemic and the first six months after the launch of ChatGPT, each period was characterised by distinctive themes reflective of the specific context and challenges. During the COVID-19 period, "Policy Making" emerged as a key theme, capturing the urgent need for strategic decisions in an unprecedented global crisis. In contrast, the post-ChatGPT period saw a surge in discourse around the "Future of Large Language Models", reflecting the anticipation and speculation about the potential advancements and challenges in the era of AI, with emphasis on concepts like quantum computing, cloud computing, and cryptography.

In conclusion, despite the differences in the thematic focus of the two periods, there are underlying similarities that present opportunities for cross-learning. The consistent reliance on quantitative methods suggests that a data-driven approach will remain critical as we navigate the GPT era. Meanwhile, the shifting focus within the research and education theme underscores the need for continual adaptation and reevaluation in these fields as technology evolves. Finally, the period-specific themes highlight the importance of contextually grounded research that addresses the unique challenges and opportunities of each period. Taken together, these insights provide valuable guidance for researchers, educators, and policy makers navigating the integration of Large Language Models like ChatGPT into the digital transformation landscape.

## References

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- [1] Ayman, U., Kaya, A.K., Kuruç, Ü.K. (2020). The impact of digital communication and pr models on the sustainability of higher education during crises†. *Sustainability* (Switzerland), 12(20), 1-15, <https://doi.org/10.3390/su12208295>.
- [2] Busu, M., Vargas, V.M., Gherasim, A. (2020). An analysis of the economic performances of the retail companies in Romania, 15(1), 125-133, <https://doi.org/10.2478/mmcks-2020>.
- [3] Chinie, C., Oancea, M., Todea, S. (2022). The adoption of the metaverse concepts in Romania. *Management and Marketing*, 17(3), 328-340, <https://doi.org/10.2478/mmcks-2022-0018>.

- [4] Dahlan, H., Ismail, M.A., Hussin, R.C. (2010). Suitability of Collaborative Learning Activities in Web 2.0 environment. 2010 International Conference on User Science Engineering, 65-70.
- [5] Dima, A.M., Maassen, M.A., Mehmanpazir, B. (2020). Perspectives of Online Education in the Context of the COVID-19 Pandemic Crisis, *Economics and Social Sciences*, 381-397, <https://doi.org/10.2478/9788366675162-041>.
- [6] Gómez Cano, C.A., Sánchez Castillo, V., Clavijo Gallego, T.A. (2023). Unveiling the Thematic Landscape of Generative Pre-trained Transformer (GPT) Through Bibliometric Analysis, *Metaverse Basic and Applied Research*, <https://doi.org/10.56294/mr202333>.
- [7] Gorina, L., Gordova, M., Khristoforova, I., Sundeeva, L., Strielkowski, W. (2023). Sustainable Education and Digitalization through the Prism of the COVID-19 Pandemic, *Sustainability (Switzerland)*, 15(8), <https://doi.org/10.3390/su15086846>.
- [8] Ionescu, C.A., Paschia, L., Nicolau, N.L.G., Stanescu, S.G., Stancescu, V.M.N., Coman, M.D., Uzla, M.C. (2020). Sustainability analysis of the e-learning education system during pandemic period – COVID-19 in Romania. *Sustainability (Switzerland)*, 12(21), 1-22, <https://doi.org/10.3390/su12219030>.
- [9] Jones, B., Iredale, N. (2009). Entrepreneurship education and Web 2.0. *Journal of Research in Marketing and Entrepreneurship*, 11(1), 66-77, <https://doi.org/10.1108/14715200911014158>.
- [10] Mata-Greve, F., Johnson, M., Pullmann, M.D., Friedman, E.C., Fillipo, I.G., Comtois, K.A., Arian, P. (2021). Mental health and the perceived usability of digital mental health tools among essential workers and people unemployed due to COVID-19: Cross-sectional survey study. In *JMIR Mental Health*, 8(8). JMIR Publications Inc. <https://doi.org/10.2196/28360>.
- [11] Peacock, S., Cowan, J., Williams, J. (2020). An Exploration Into the Importance of a Sense of Belonging for Online Learners. In *International Review of Research in Open and Distributed Learning*, 21(2).
- [12] Petracca, F., Ciani, O., Cucciniello, M., Tarricone, R. (2020). Harnessing digital health technologies during and after the COVID-19 Pandemic: Context matters. In *Journal of Medical Internet Research*, 22(12). JMIR Publications Inc. <https://doi.org/10.2196/21815>.
- [13] Usluel, Y K., Mazman, S.G. (2009). Adoption of Web 2.0 tools in distance education, *Procedia - Social and Behavioral Sciences*, 1(1), 818-823, <https://doi.org/10.1016/j.sbspro.2009.01.146>.
- [14] Xie, X., Siau, K., Nah, F.F.H. (2020). COVID-19 pandemic – online education in the new normal and the next normal, *Journal of Information Technology Case and Application Research*, 22(3), 175-187, <https://doi.org/10.1080/15228053.2020.1824884>.
- [15] Yan, L., Sha, L., Zhao, L., Li, Y., Martinez-Maldonado, R., Chen, G., Li, X., Jin, Y., Gašević, D. (2023). Practical and Ethical Challenges of Large Language Models in Education: A Systematic Literature Review, <http://arxiv.org/abs/2303.13379>.
- [16] Yu, H. (2023). Reflection on whether Chat GPT should be banned by academia from the perspective of education and teaching. In *Frontiers in Psychology*, Vol. 14, Frontiers Media S.A., <https://doi.org/10.3389/fpsyg.2023.1181712>.