Applications of Artificial Intelligence in modern educational system

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I Introduction

Over the past decade, Artificial Intelligence (AI) become a widespread technology in different areas of human life. One of the most promising and under-studied areas of application of AI is education [1]–[3]. Our research focuses on generative large language models (GLLMs) and AI software tools (AISTs) that can have an ambiguous impact on the learning process [4]–[6]. Specifically, AI can become either an indispensable assistant or an adversary that decreases the pace of learning. Therefore, our study aims to understand how AI technologies influence academic performance of high school and university students and validate two hypotheses.

H1: GLLMs and AISTs have a more benefits for university students than school students.

H2: GLLMs, in comparison with classical learning approaches and AISTs, will have the most beneficial effect on improving the academic performance of students of schools and universities.

II Literature Review

Our sample of academic publications identified two primary applications of AI that could be used for various learning purposes and might lead to distinct effects on students' academic performance.

The first application of AI is GLLMs, a type of Natural Language Processing model that generates human-like text based on a given input. From the perspective of improvements in academic performance, GLLMs can support writing [7], assist with medicine [8] and language [7] learning and provide customized feedback [5], [7]. However, students can use GLLM-generated content to cheat on assignments, which impedes them from developing essential critical thinking and problem-solving skills [4]–[7].

The second application is AISTs which are designed to solve specialized problems. Chen *et al.* [9] provide a list of the 30 most common AISTs actively used for education nowadays. For instance, [10] created a video recommendation system, analyzed its impact

on academic performance, and came to the conclusion that AISTs are useful for students. [11] claims that students were able to use language models wisely and even became more interested in learning. AISTs turned out to be beneficial for education.

The field of AI applications in education has received limited research attention, and we were unable to find any studies that simultaneously explored the impact of GLLMs and AISTs on students' academic performance. Furthermore, we found that the reviewed studies have compared these AI systems neither with each other nor with the system of classical digital education. Given this context, our future research aims to fill this gap and offer our perspective on the educational implications of the highlighted AI categories.

III Methodology

Based on the inductive approach, we decided to conduct an elective course in mathematical discipline for public school and university students. We will try to form an overall view of how AI technologies affect the performance of students of different ages and levels of education.

For the experiment, we decided to deliver eight-week elective courses in mathematics, since math and language studying are the most common applications for AI-based educational tools [9], but math skills assessment is more straightforward and less biased due to reduced human factor. We'll use course materials from the educational institutions attended by the selected groups to ensure equal studying conditions. We will also find a specialist to choose one of the possible AISTs and GLLMs (see Appendices A and B respectively) and create educational materials for their application.

To choose the students for the courses, we will conduct a sampling procedure based on the clustering approach. Six groups of around 30 pupils each will participate in the study: high school pupils and university students, each one of which, in turn, is divided into subgroups with classical education, education with AISTs, and education with GLLMs. Moreover, young people from each group should have the same education level and study in non-technical institutions. We will take three classes of the same grade in one high school and three groups from the same course in one university. A similar approach was applied in [10], [12], [13], and we projected their tactics onto our study.

To evaluate academic performance, examinations will be conducted before, immediately after, and at a later time following the course [14], [15]. Additionally, to follow the student's progress during the class sessions, weekly quizzes will be executed [16].

After the assessments, we will evaluate the success of each group that used AISTs and GLLMs compared to those that used traditional education methods. We will also compare the effectiveness of AISTs and GLLMs and identify which one is better. Additionally, we will compare the academic performance of students in schools and universities to determine which age students used AI more successfully. The research is expected to take one year to complete.

Unlike other methods, our procedure is optimal for our research design and has gained widespread acceptance among the scientific community. However, we have several critical limitations that we have to overcome. Firstly, educational institutions may disagree to provide access to the required sample of students and facilities that can be used to organize our experiment. Therefore, it is important to enlist the support of the municipal education administration. Secondly, we need to find a competent methodologist for creating teaching materials for groups utilizing AI systems. We plan to use outsourcing platforms with a large selection of candidates. Finally, we may have difficulty gaining access to the AI tools that will be used in the study process. We plan to address this limitation by obtaining a grant to cover paid subscriptions to AI tools.

IV Anticipated results

At the end of our experiment, we expect to obtain multiple results. Firstly, we assume that, as a result of comparing group learning approaches, the elective program that included GLLMs will have the most positive impact on the academic performance of students on the side of effective assimilation and understanding of the course material. Secondly, the rates of growth in academic performance and overall course progress in groups with AI tools in university will be better than in school.

V Discussion

The anticipated outcomes indicate that AI systems are efficient tools for facilitating the learning process. GLLMs are going to show the best performance as they have already demonstrated successful handling of different educational tasks that pertain to information retrieval and explanation, thereby serving as an assistant in the learning process [2], [3]. The impact of AI is promising especially for university students, who utilize AI more wisely. We assume that university students are more interested in the learning process, unlike school students, who need specific guidelines and constant monitoring.

Our study addresses a crucial gap in the field of knowledge on AI's use in education. Earlier research have examined the impacts of AI on students' motivation and the general applications of AI [10], [11], but none of them compared the effects of GLLMs and AISTs on education. Our goal is to compare these AI technologies, comprehend their impact on academic performance, and conduct an experiment that yields a wealth of less biased data regarding the effects of GLLMs and AISTs.

This paper may give educational institutes the direction for the future development of AI and help them implement AI in education. If our research findings are not approved, society may fail to utilize AI effectively and the fast-growing trend of AI use among young people might have unpredictable effects on the educational process. Our work can be applied to tackle this potential problem by explaining AI effects on modern education.

Our research has several limitations that may affect the relevance and reliability of the results. Firstly, our experimental procedure has a small sample size, which will lead to selection bias and a lack of generalizability. Secondly, we might have difficulties with analyzing the AI systems because they could dynamically change and adapt to the experiment environment. Finally, we are inexperienced in course delivery, working with AI systems and statistical data processing.

Thus, to increase the generalizability of our findings, we recommend future studies to involve more experienced professionals, increase the sample size, conduct investigations for each new AI model and check its applicability in various disciplines. With these suggestions, future studies can build upon our research and advance the field of AI in education.

References

[1] T. Wang and E. C. K. Cheng, "An investigation of barriers to hong kong k-12 schools incorporating artificial intelligence in education," *Comput. Educ: Artif. Intell.*, vol. 2, Aug. 2021. DOI: 10.1016/j.caeai.2021.100031.

[2] M. Zafari, J. S. Bazargani, A. Sadeghi-Niaraki, and S.-M. Choi, "Artificial intelligence applications in k-12 education: A systematic literature review," *IEEE Access*, vol. 10, pp. 61 905–61 921, May 2022. DOI: 10.1109/ACCESS.2022.3179356.

[3] L. Chen, P. Chen, and Z. Lin, "Artificial intelligence in education: A review," *IEEE Access*, vol. 8, pp. 75 264–75 278, 2020. DOI: 10.1109/ACCESS.2020.2988510.

[4] W. M. Lim, A. Gunasekara, J. L. Pallant, J. I. Pallant, and E. Pechenkina, "Generative ai and the future of education: Ragnarök or reformation? A paradoxical perspective from management educators," *Int. J. Manage. Educ.*, vol. 21, no. 2, Jul. 2023, ISSN: 1472-8117. DOI: 10.1016/j.ijme.2023.100790.

[5] E. Kasneci *et al.*, "ChatGPT for good? on opportunities and challenges of large language models for education," *Learn. Individual Differences*, vol. 103, Apr. 2023. DOI: 10.1016/j.lindif.2023.102274.

[6] E. P. H. Choi, J. J. Lee, M.-H. Ho, J. Y. Y. Kwok, and K. Y. W. Lok, "Chatting or cheating? the impacts of chatgpt and other artificial intelligence language models on nurse education," *Nurse Educ. Today*, vol. 125, Jun. 2023, ISSN: 0260-6917. DOI: 10.1016/j.nedt.2023.105796.

[7] Y. K. Dwivedi *et al.*, ""So what if ChatGPT wrote it?" Multidisciplinary perspectives on opportunities, challenges and implications of generative conversational AI for re-

search, practice and policy," *Int. J. Inf. Manage.*, vol. 71, Aug. 2023, ISSN: 0268-4012. DOI: 10.1016/j.ijinfomgt.2023.102642.

[8] T. Kung *et al.*, "Performance of ChatGPT on USMLE: Potential for AI-assisted medical education using large language models," *PLOS Digit. Health*, vol. 2, Feb. 2023. DOI: 10.1371/journal.pdig.0000198.

[9] X. Chen, H. Xie, and G.-J. Hwang, "A multi-perspective study on artificial intelligence in education: Grants, conferences, journals, software tools, institutions, and researchers," *Comput. Educ: Artif. Intell.*, vol. 1, Oct. 2020, ISSN: 2666-920X. DOI: 10.1016/j.caeai.2020.100005.

[10] A. Y. Huang, O. H. Lu, and S. J. Yang, "Effects of artificial intelligence–enabled personalized recommendations on learners' learning engagement, motivation, and outcomes in a flipped classroom," *Comput. Educ.*, vol. 194, Mar. 2023, ISSN: 0360-1315. DOI: 10.1016/j.compedu.2022.104684.

[11] T. K. Chiu, Q. Xia, X. Zhou, C. S. Chai, and M. Cheng, "Systematic literature review on opportunities, challenges, and future research recommendations of artificial intelligence in education," *Comput. Educ: Artif. Intell.*, vol. 4, 2023, ISSN: 2666-920X. DOI: 10.1016/j.caeai.2022.100118.

[12] I. Diachenko, S. Kalishchuk, M. Zhylin, A. Kyyko, and Y. Volkova, "Color education: A study on methods of influence on memory," *Heliyon*, vol. 8, 11 Nov. 2022, ISSN: 2405-8440. DOI: 10.1016/j.heliyon.2022.e11607.

[13] M. L. Nolé, J. L. Higuera-Trujillo, and C. Llinares, "Effects of classroom design on the memory of university students: From a gender perspective," *Int. J. Environ. Res. Public Health*, vol. 18, no. 17, Sep. 2021, ISSN: 1660-4601. DOI: 10.3390/ijerph18179391.

[14] M. Haavisto, T. Jaakkola, and J. Lepola, "Video outperforms illustrated text: Do old explanations for the modality effect apply in a learner-paced fifth-grade classroom context?" *Comput. Educ.*, vol. 199, Jul. 2023, ISSN: 0360-1315. DOI: 10.1016/j.compedu.2023.104775.

[15] C. A. N. Knoop-van Campen, E. Segers, and L. Verhoeven, "The modality and redundancy effects in multimedia learning in children with dyslexia," *Dyslexia*, vol. 24, no. 2, pp. 140–155, May 2018. DOI: 10.1002/dys.1585.

[16] J. Guzmán *et al.*, "Teaching control during the covid-19 pandemic," *IFAC-PapersOnLine*, vol. 55, no. 17, pp. 31–36, 2022, ISSN: 2405-8963. DOI: 10.1016/j.ifacol.2022.09.221.

Appendix A

List of AISTs:

1. Carnegie Learning;
2. CueThink;
3. DreamBox Learning;
4. Quizlet;
5. Symbolab;
6. Thinkster Math;
7. TrueSelf;
8. Maths AI App;
9. Talk2Learn;
10. Photomath;
11. WolframAlpha.

Appendix B

List of GLLMs:

1. Third and fourth generation of ChatGPT
2. BERT
3. RoBERTa
4. XLNet
5. BLOOM