Large language models Challenges and Opportunities in Education

ANDREW KIPKEBUT
Department of computer science and I.T, Kabarak University, Kenya

Abstract- ***Large language models (LLMs) have emerged as powerful tools in the field of education, offering opportunities to transform learning experiences from both the teacher and the student. These tools have been used for a range of application such as document translation, customized learning, information access, learning new languages, content generation as well as developing programming applications. This paper investigates the potential benefits and challenges associated with integrating LLMs into educational environment. Through a comprehensive review of existing literature and case studies, the paper examines how LLMs can enhance information access, personalize learning experiences, aid language acquisition, facilitate content generation, and improve data accessibility. Moreover, the paper explores the limitations of LLMs, including their lack of context understanding, potential for bias and misinformation, limited capacity for fostering critical thinking skills, tendency to promote dependence on technology, and ethical concerns. By critically analysing both the opportunities and challenges, this paper aims to provide in formative insights for educators, students, policymakers, governments and researchers to maximize the benefits of LLMs while mitigating their limitations in educational contexts.***

Index Terms- ***Bias, Content Generation, Education, Ethical Concerns, Information Access Large Language Models, Personalized Learning.***

I. INTRODUCTION

Recently Large Language Models (LLMs) has steered in a new era of possibilities in the education sector. These models, with their incredible capacity to process and generate text, offer a plethora of opportunities to revolutionize teaching and learning practices. From providing instant access to vast amounts of information to personalizing learning experiences, LLMs hold the potential to reshape the future of educational .However, alongside the promise of LLMs come significant challenges and opportunities and considerations. As educators and researchers explore the integration of these models into educational settings, it becomes important to critically evaluate both their shots and misses. While LLMs offer unparalleled capabilities in information retrieval, content generation, and language support, they also pose concerns regarding their understanding of context, susceptibility to biases, and ethical implications. This paper aims to delve into the efficacy and challenges of LLMs in education, providing a comprehensive analysis of their potential impact. By exploring real-world applications, case studies, and research findings, the paper seek to shed light on how LLMs can be harnessed to enhance learning experiences while addressing the intrinsic challenges and risks associated with its adoption. Through this research, we aim is to equip educators, policymakers, and researchers with the knowledge and insights needed to navigate the complexities of integrating LLMs into educational landscape. By understanding both the opportunities and pitfalls, stakeholders can make informed decisions and develop strategies to maximize the benefits of LLMs while mitigating their drawbacks in educational contexts.

II. RELATED WORK

The field of LLM applications in education is quite new, but there's a growing body of research exploring its potential. Previous studies have explored the integration of artificial intelligence (AI) technologies in education, focusing on areas such as intelligent tutoring systems, adaptive learning platforms, and educational chatbots (Wang et al 2024). These provide valuable insights into the potential benefits and challenges of leveraging AI to support teaching and learning processes. Research in natural language processing (NLP) has made significant strides in developing large-scale

language models, such as GPT (Generative Pre-trained Transformer) and BERT (Bidirectional Encoder Representations from Transformers) (Min et al, 2023), studies in this domain have investigated various applications of language models, including text generation, sentiment analysis, and language understanding tasks. Large language models (LLMs) have the potential to greatly benefit education by assisting students and teachers by preparing students for a new kind of work, personalizing education, reducing time-consuming tasks, improving accessibility and inclusivity, and providing multilingual support(Alqahtani, et al,2023). LLMs hold immense promise for improving education and research quality and its presence is growing stronger every minute. As LLM advances we should expect even more ground-breaking innovation in education that will positively affect the future of education. At the beginning of 2023 LLMs dominated the tech landscape, with ChatGPT leading in adoption and innovation (Javaid, et al 2023). 2024 saw LLMs bridging the gap between theoretical research and practical industry applications (Farzanehpour,2024). Kasneci et al. (2023) highlighted that for large language models to be effectively used in education, both teachers and learners need to develop specific competencies and literacies. These are essential for understanding the technology, its limitations, and its potential brittleness. The authors argue that a well-defined strategy within educational systems, along with a strong pedagogical approach focusing on critical thinking and fact-checking strategies, is necessary to fully integrate and leverage large language models in teaching and learning environments.

III. METHODOLOGY

The study employed a comprehensive mixed-methods approach to thoroughly assess the impact of large language models (LLMs) on the education sector. This methodology combined both quantitative and qualitative techniques to provide a nuanced understanding of the subject. Quantitative data were collected through surveys administered to 175 participants, including faculty and students, from Kenya, Tanzania, Uganda, Malaysia and Ethiopia. The surveys aimed to measure various aspects of LLM usage, including effectiveness, perceived benefits, and challenges in educational contexts. Structured questions in the survey gathered numerical data on participants' experiences and attitudes towards LLMs. To complement the quantitative findings, qualitative data were obtained through detailed questionnaires and focus group discussions. These qualitative methods offered deeper insights into participants' personal experiences, perceptions, and detailed views on the use of LLMs in education. Focus groups, in particular, facilitated interactive discussions, allowing participants to share their thoughts in a more detailed and contextual manner. The study's regional focus ensured a broad representation of educational environments and perspectives, enhancing the generalizability and relevance of the findings. Quantitative data were analyzed using statistical methods to identify trends and patterns, while qualitative data were examined through thematic analysis to extract key themes and insights. This integration of both data types provided a comprehensive view of the impact of LLMs on education, capturing both measurable outcomes and rich, contextual understanding.

IV. RESULTSAND DISCUSSION

A total of 175 individuals participated in the study across Kenya, Tanzania, Ethiopia, and Malaysia. This sample consisted of 133 students and 36 faculty members, with a gender distribution of 122 males (70%) and 53 females (30%). Among the students, 98 were undergraduates (73%), 42 were master's students (32%), and 18 were PhD students (14%).Regarding the frequency of LLM usage, 73 participants (42%) used LLMs daily, 56 participants (32%) used them weekly, and 35 participants (20%) used them rarely. When examining the impact of LLM usage on engagement and academic performance, daily users of LLMs reported the most significant benefits. Approximately 85% of daily users felt that LLMs greatly improved their study efficiency. This group also showed a notable 10% improvement in academic performance scores compared to non-users. In contrast, weekly users experienced a moderate 5% increase in performance and reported a 60% positive impact from LLMs. Rare users, however, found minimal benefit, with only 30% acknowledging any usefulness from LLMs, and no significant improvement in academic performance was observed.

Country responses

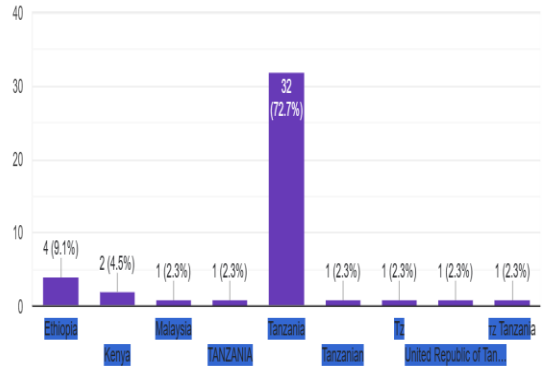

Figure 1. Country response graph

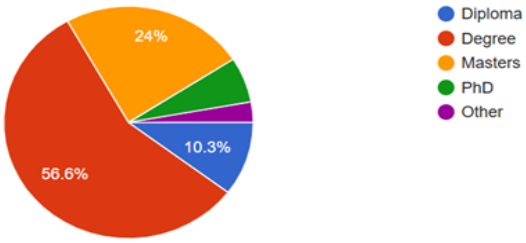

Figure 2. Participants education level

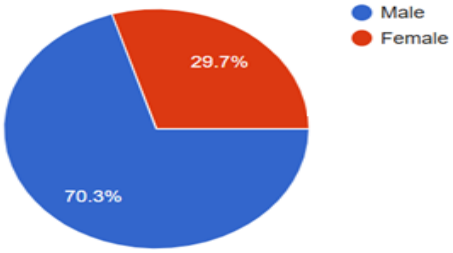

Figure 3. Participant gender.

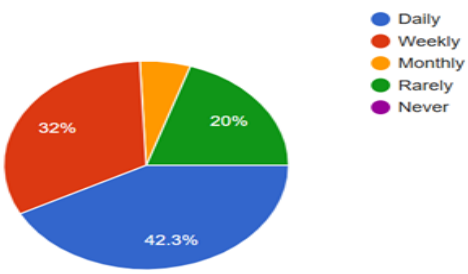

Figure 4. LLM usage.

Among the 175 participants in the study, generative AI tools were used for various purposes, reflecting their diverse needs. The most common use was for research and data gathering, with 137 participants (78%) leveraging these tools to assist with their information needs and data collection tasks. This was followed by study aids, which were utilized by 108 participants (62%) to support their learning processes and enhance their educational experiences. Writing assistance was another significant area of use, with 70 participants (40%) employing generative AI tools to help draft, edit, and refine their written work. In contrast, programming support was less common, with 41 participants (23%) using the tools for coding help and debugging. Personalized learning experiences were sought by 69 participants (39%), indicating an interest in tailoring educational content to individual needs. However, there was little to no use of generative AI for image generation and assessment, with very few participants reporting these purposes. Additionally, only few participant (1%) used generative AI for grammar checking, highlighting its limited application in this specific area.

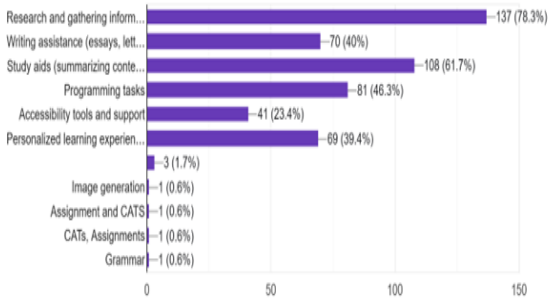

Figure 5. GenAI purpose

Among the 175 participants, large language models (LLMs) could offer valuable support to educators in several key areas: Lesson Planning and Curriculum Development: With 106 participants (61%) using LLMs for lesson planning and curriculum development, these tools can assist educators by generating lesson plans, suggesting teaching resources, and creating educational materials tailored to specific learning objectives. LLMs can provide ideas for engaging activities, help structure curriculum content, and offer suggestions for incorporating various pedagogical approaches. Grading and Assessment: For 55 participants (31%), LLMs can streamline the grading process by automating the evaluation of assignments and providing feedback. They can assist in creating and grading quizzes and exams, and offer consistent and objective assessments of student work. Additionally,

LLMs can help educators design rubrics and analyze assessment data to identify trends and areas for improvement.

Providing Differentiated Instructions: LLMs can support differentiated instruction by generating customized learning materials and resources tailored to different student needs and levels. This can include creating alternative explanations, adjusting the complexity of content, and offering additional practice problems or enrichment activities for students with varying levels of understanding.55 out of 175 participants use LLMs for grading and assessment, it represents about 31% of the participants. This indicates that while LLMs are popular for lesson planning and curriculum development, they are less commonly used for grading and assessment but still play a significant role for those who use them in this way. With 130 out of 175 participants (about 74%) using LLMs for content creation and interaction, it's clear that these tools are highly valued for generating educational materials and engaging with students. Overall, LLMs can significantly enhance educators' efficiency and effectiveness by automating routine tasks, providing valuable insights, and offering tailored support to meet diverse educational needs.

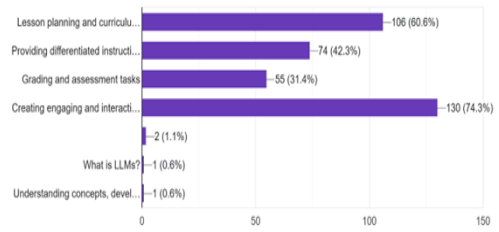

Figure 6: Support to educators

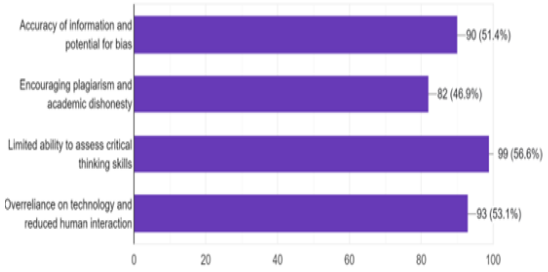

Figure 7: Education concerns.

Among the 175 participants, several concerns about using large language models (LLMs) in education were prominently noted. One major concern is the accuracy of information and potential bias in the content generated by LLMs. Participants worry that these tools might produce incorrect or biased information, which could impact the quality and reliability of educational materials. Additionally, 82 participants (47%) expressed concerns that LLMs might encourage plagiarism and academic dishonesty. There is apprehension that students could misuse these tools to produce work that isn't their own, thereby compromising the integrity of academic assessments and assignments. Another significant concern, raised by 90 participants (51%), is the limited ability of LLMs to assess critical thinking skills. There is a belief that these tools might not effectively evaluate or nurture deeper cognitive processes, which are essential for thorough learning and understanding.

Lastly, 99 participants (57%) worried about the overreliance on technology. They fear that excessive dependence on LLMs could lead to a reduction in fundamental skills such as problem-solving and independent thinking, as well as a potential loss of traditional teaching methods and human interaction.

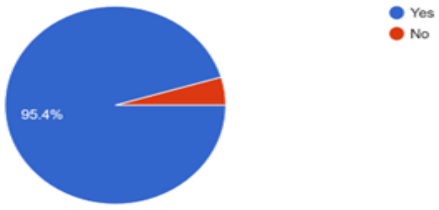

Figure 8: AI tools

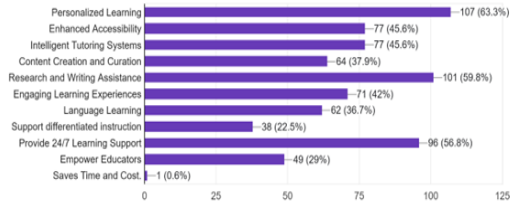

Figure 9: Education opportunities

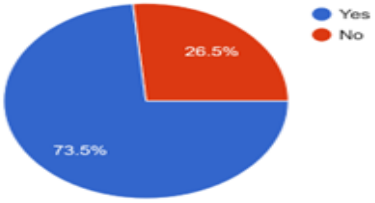

Figure 10. Ethical awareness

The 26% who are not aware highlight a gap in understanding the ethical implications of LLMs.

This underscores the importance of educational initiatives focused on AI ethics. Schools, universities, and training programs can play a crucial role in integrating AI ethics into their curricula

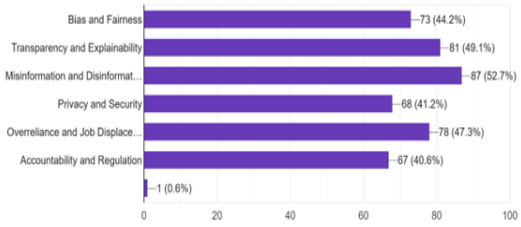

Figure 11. Ethical awareness

73 out of 175 participants (approximately 42%) concerned about ethical issues, bias, and fairness, it's evident that these are significant considerations when using LLMs in education. Transparency and Explainability (49%): Nearly half of the participants emphasize the need for transparency and explainability. This shows that there is a strong demand for understanding how LLMs make decisions and ensuring that their outputs are interpretable and accountable. 87 out of 175 participants (about 50%) focusing on misinformation and disinformation, it's clear that these issues are a major concern in the context of using LLMs. This reflects the potential risks associated with the information generated by LLMs With 68 out of 175 participants (about 39%) concerned with privacy and security, it's evident that these are important considerations when using LLMs in education. Generally, these concerns underscore the need for robust security measures and privacy protocols to protect both educators and students when interacting with LLMs.

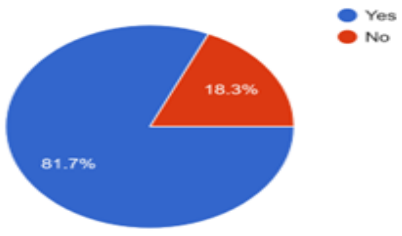

Figure 12.LLM integration in education

81% of participants supporting the integration of large language models (LLMs) in education and 18% expressing reservations, it's clear that there is significant interest in leveraging AI technologies to enhance learning. This strong support highlights several opportunities and considerations for educators and institutions as they explore integrating LLMs into the educational landscape.There is strong support for involving a diverse group of stakeholders in the development of large language models (LLMs). With 118 out of 175 participants (about 68%) advocating for the involvement of educational experts in LLM development, it's clear that there's a strong belief in the value of their input. Educational experts can provide crucial insights into Curriculum Integration, Pedagogical Effectiveness, Content Accuracy and Relevance. A majority of participants, 104 out of 175 (about 59%), believe that LLM developers and researchers should be deeply involved in the development process. Their expertise is crucial for ensuring the technical robustness and scientific validity of the models. Additionally, 81 participants (46%) highlight the importance of UI/UX designers. These designers play a key role in enhancing the usability and user experience of LLMs, ensuring that the technology is accessible and effective for its users.Ethics and policy makers are also seen as essential contributors by 85 participants (49%). Their involvement is critical for addressing ethical concerns, managing biases, and ensuring compliance with legal and regulatory standards. Furthermore, the perspectives of students and educators are highly valued, with 114 out of 175 participants (65%) supporting their inclusion. This group provides valuable insights into how LLMs can be tailored to meet educational needs and improve teaching and learning experiences. Conversely, only 1% of participants feel that regulatory bodies should be directly involved in the development process. This suggests that while regulatory oversight is important, the role of regulatory bodies might be seen as more about providing guidelines and ensuring compliance rather than active participation in the development of LLMs.

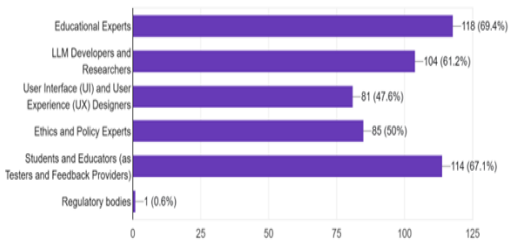

Figure 13. LLM stakeholders

Proposed framework for Integrating Large Language models in education

The proposed framework provides a structured approach on integrating large language models in education, emphasizing collaboration, training, and continuous evaluation. By addressing the needs of all stakeholders and focusing on sustainability, this framework aims to maximize the potential benefits of LLMs in enhancing teaching and learning experiences today. The framework consists of the following stages.

Stage 1. Needs Assessment by Identifying the specific educational needs and goals that LLMs can address, this can be achieved by conducting surveys and interviews with educators, students, and university administrators in order to understand existing misses and shots in education.
Stage 2. Stakeholder Engagement that involves all relevant stakeholders in the planning and implementation process. This can be achieved by forming a steering committee comprising of lecturers, students, parents, and IT specialists, policy makes through workshops with focused groups.
Stage 3. Resource Allocation through Identification and allocating the necessary resources for successful implementation, this can be achieved through assessment of technical infrastructure needs, such as hardware, software, and internet connectivity.
Stage 4. Training and Professional Development by equiping educators with the skills and knowledge to effectively use LLMs in their teaching. This can be achieved by developing and delivering training programs focusing on the pedagogical use of LLMs and technical skills.
Stage 5. Curriculum Integration that Seamlessly incorporate LLMs into the existing curriculum by Identifying areas of the curriculum where LLMs can add the most value (e.g., personalized learning pathways, language practice) among others
Stage 6. Implementation and Monitoring through launching the LLM initiative and monitoring its progress and impact. This can be achieved by using digital tools and platforms to track progress and collect data on usage and effectiveness.
Stage 7. Evaluation and Feedback by evaluating the impact of LLMs on educational outcomes and gathering feedback for improvement through regular evaluations using both quantitative and qualitative data.
Stage 8. Scalability and Sustainability to ensure the long-term success and scalability of the LLM in education.

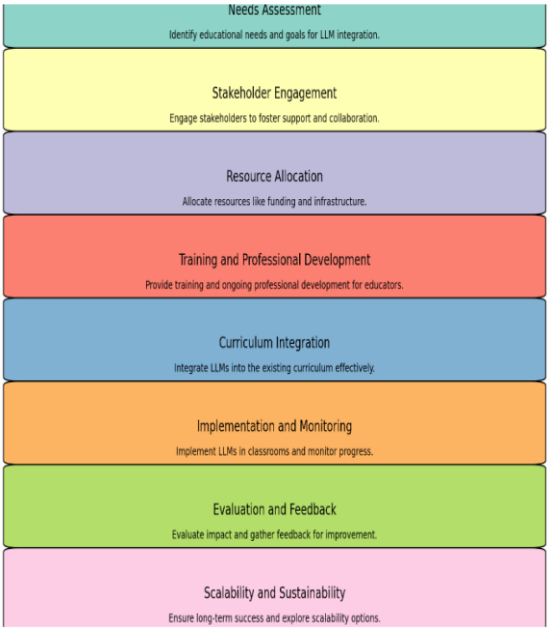

Figure 14: Proposed Framework

CONCLUSION

These findings suggest that LLMs can substantially enhance learning outcomes, especially when used regularly. Educational institutions might consider promoting daily use of LLMs among students to maximize these benefits. However, the mixed responses from faculty highlight the need for further support and training to address concerns about the integration and quality of LLM content. The study highlights the importance of involving a diverse range of stakeholders in the development of large language models (LLMs). There is a clear consensus that LLM developers and researchers, UI/UX designers, ethics and policy makers, and educators all play crucial roles in creating effective and responsible models. Developers and researchers are essential for ensuring technical and scientific rigor, while UI/UX designers enhance usability and user experience. Ethics and policy makers are needed to address ethical concerns and ensure compliance with regulations, and educators provide valuable insights into aligning LLMs with educational needs. The study also reveals that LLMs are primarily used for content creation and interaction within educational contexts, with a significant portion of participants recognizing their value in these areas

REFERENCES

[1] Alqahtani, T., Badreldin, H. A., Alrashed, M., Alshaya, A. I., Alghamdi, S. S., bin Saleh, K., ... & Albekairy, A. M. (2023). The emergent role of artificial intelligence, natural learning processing, and large language models in higher education and research. *Research in Social and Administrative Pharmacy*, *19*(8), 1236-1242.

[2] Javaid, M., Haleem, A., Singh, R. P., Khan, S., & Khan, I. H. (2023). Unlocking the opportunities through CHATGPT tool towards ameliorating the education system. *BenchCouncil Transactions on Benchmarks, Standards and Evaluations*, (2), 100115. https://doi.org/10.1016/j.tbench.2023.100115

[3] 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.

[4] Min, B., Ross, H., Sulem, E., Veyseh, A. P. B., Nguyen, T. H., Sainz, O., ... & Roth, D. (2023). Recent advances in natural language processing via large pre-trained language models: A survey. *ACM Computing Surveys*, *56*(2), 1-40.

[5] Wang, S., Xu, T., Li, H., Zhang, C., Liang, J., Tang, J., ... & Wen, Q. (2024). Large language models for education: A survey and outlook. *arXiv preprint arXiv:2403.18105*.