IJARSCT
ISSN (Online) 2581-9429
International Journal of Advanced Research in Science, Communication and Technology (IJARSCT)
International Open-Access, Double-Blind, Peer-Reviewed, Refereed, Multidisciplinary Online Journal
Impact Factor: 7.53
Volume 4, Issue 1, January 2024

Exploiting Artificial Intelligence for Personalized Assistance Technology in Learning Disabilities

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Abstract: *This research is to explore the profound impacts of AI-driven personalized assistive technology on the area of learning impairments within the Saudi Arabian setting. The aim of this study is to evaluate the potential benefits of technology in enhancing the reading comprehension, mathematics skills, and cognitive abilities of children who struggle with learning. Strictly quantitative research methodology was used in this study, and academic performance was thoroughly evaluated both before and after the intervention. Following the intervention, the individuals' performance in all three areas significantly improved. Furthermore, the qualitative data analysis revealed a multitude of favorable thoughts and experiences given by students engaging with the cutting-edge AI-powered technology. The results show how crucial it is to prioritize user-centric design principles and shed light on the fascinating possibilities of using AI-driven technology to help kids with learning disabilities succeed academically. The findings of this study point to the use of AI-powered solutions in classroom environments to support students who struggle with learning, which has significant implications for the creation of customized assistive technology*

Keywords: AI-powered technology, personalized assistive technology, learning disabilities

I. INTRODUCTION

People with learning disabilities face substantial obstacles in their social and academic life. Therefore, in order to create an inclusive learning environment and ensure that every student has equal opportunity, these challenges must be addressed and conquered. It is alarming that learning disabilities are becoming a more popular topic of discussion in Saudi Arabia. Research has shed light on how common these impairments are, showing that a significant portion of the population—roughly 10% to 15%—had different types of learning disabilities. These disabilities may have a significant and enduring effect on individuals, impairing their capacity to advance academically, diminishing their self-esteem, and restricting their possibilities for potential future employment.

With the goal of enhancing educational results and fostering the independence of individuals with learning disabilities, assistive technology development has grown to be a highly regarded tool. According to Beukelman and Mirenda (2019), "assistive technology" encompasses a wide variety of tools, applications, and services that have been specially created to address the special learning requirements of individuals with disabilities. By providing individualized help and modifications, assistive technology has the potential to improve education, promote self-sufficiency, and provide an inclusive learning environment.

The integration of artificial intelligence (AI) with customized assistive technology has significant potential for revolutionizing the educational experience for people with impairments. Artificial intelligence (AI) is a broad topic that includes many different technical developments, including computer vision, machine learning, and natural language processing. By facilitating the creation of intelligent and flexible instructional materials, these cutting-edge instruments have the potential to completely transform the field of education. By carefully analyzing vast volumes of data and incorporating user engagement insights, artificial intelligence-powered assistive technology can tailor feedback, learning strategies, and content to meet the unique needs and preferences of individual students.

Several academic studies have already shown the beneficial impact of assistive technology powered by artificial intelligence (AI) on the academic performance of students with impairments. Johnson et al. (2021) performed a ground-

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breaking research in which the effectiveness of a novel AI-driven tailored reading intervention was experimentally shown. This randomized controlled trial's findings showed that dyslexic pupils' reading comprehension and performance had significantly improved. Similarly, Smith and Wang's (2020) research detailed the exceptional effectiveness of an AI-powered math tutoring system in enhancing the problem-solving skills and mathematical fluency of children with arithmetic learning impairments.

Moreover, the use of artificial intelligence in customized assistive technology is quite significant and goes beyond the boundaries of educational settings. Artificial intelligence (AI) integration has the potential to improve the general well-being of people with learning difficulties and make it easier for them to acquire critical life skills. Furthermore, the incorporation of artificial intelligence (AI) into assistive technology presents significant opportunities to enhance the effectiveness of early intervention programs and customized learning plans, ultimately leading to better outcomes over the long run.

Artificial intelligence (AI) has opened up a world of intriguing prospects in the field of customized assistive technology. However, a number of problems and challenges need to be identified and resolved in order for it to be carried out properly. The ethical ramifications of algorithmic bias, data privacy, and learner well-being need to be carefully explored in order to safeguard learners' rights and welfare. Furthermore, it is imperative to give top attention to developing standards for accessibility and affordability for AI-powered assistive technology in order to provide equitable access for students from all backgrounds.

Given the increasing amount of scholarly literature emphasizing the advantages of assistive technology driven by artificial intelligence, further investigation is required into the use and integration of these cutting-edge technologies within the particular circumstances of Saudi Arabia. The primary objective of this project is to make a substantial contribution to the field by investigating the potential effects of AI-driven customized assistive technology on the educational experiences of individuals with cognitive impairments within the context of the Saudi Arabian educational system. The major objective of this research is to provide the groundwork for a complete and encouraging learning environment for Saudi Arabian students with learning difficulties via a thorough review of existing efforts and the creation of a new theoretical framework.

Research Objective

The primary objective of this research is to explore the potential applications of artificial intelligence (AI) in the area of tailored assistive technology, with a focus on mitigating the prevalent learning challenges in Saudi Arabia. The main objective of this research is to thoroughly assess the state of assistive technology today and investigate the challenges of introducing artificial intelligence (AI) into this sector. We want to observe the many opportunities and issues that this integration brings about by doing this. Furthermore, our objective is to develop a comprehensive framework that would facilitate the efficient use of AI-powered customized assistive technology. Through the diligent pursuit of this research project, the study aims to make a substantial contribution to inclusive education, improving the educational experience and outcomes for Saudi Arabia's learning-disabled population.

II. LITERATURE REVIEW AND PREVIOUS STUDY

People who have learning disabilities face several obstacles in their pursuit of an education since these issues may make it more difficult for them to learn and process information. Since it allows for individualized treatments and modifications, assistive technology has gained widespread recognition as a useful tool for supporting individuals with learning disabilities. Artificial intelligence (AI) integration into customized assistive technology is one very promising strategy for effectively satisfying the many demands of individuals with disabilities. This section will undertake a comprehensive analysis of the body of prior scholarly literature on the use of assistive technology driven by artificial intelligence (AI) to individuals with learning disabilities.

The benefits of assistive technology, made possible by artificial intelligence, on the academic achievement and educational outcomes of people with disabilities have been well shown by several academic research. For example, a well-designed randomized controlled research was carried out by Johnson et al. (2021) to show the efficacy of an artificial intelligence-powered customized reading intervention. The reading comprehension and competence of the children who struggled with dyslexia significantly improved with this intervention, which was created to meet their

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unique needs. Similarly, Smith and Wang's (2020) study found that the usage of an AI-powered mathematics teaching system significantly improved the problem-solving and mathematical fluency of children with arithmetic learning impairments.

In the areas of language development and communication, artificial intelligence has grown in popularity, particularly for those who have learning disabilities. Artificial intelligence (AI)-powered gadgets that enhance and extend communication tactics for individuals with speech and language problems have recently been created by a dedicated group of researchers (Barton et al., 2019; Roche et al., 2020). These cutting-edge tools enable clear communication and meaningful dialogue by using machine learning algorithms and natural language processing.

Furthermore, integrating artificial intelligence (AI) into assistive technology has shown significant potential in improving cognitive and executive functioning in those with learning disabilities. Mashael et al. (2021) carried out a comprehensive study to ascertain the effectiveness of an AI-driven cognitive training program in enhancing working memory, problem-solving abilities, and attention deficiencies in people with attention deficit hyperactivity disorder (ADHD). The inherent adaptability of artificial intelligence enables the effective implementation of tailored interventions that address the unique cognitive profiles and requirements of individual pupils.

Furthermore, the creation of inclusive and accessible learning environments may be greatly aided by the incorporation of artificial intelligence (AI) into assistive technology. The significance of artificial intelligence (AI) in creating intelligent tutoring systems tailored to the unique learning preferences and styles of students with disabilities was highlighted by Al-Gahtani et al. (2021). These intelligent systems provide guidance and instructional materials across several modalities via the strategic use of artificial intelligence algorithms, ensuring that the learning process is accessible and inclusive to a broad spectrum of learners.

Data privacy and ethical concerns must be carefully considered when integrating AI-driven assistive technology, since they are essential to the deployment process. Scholars have highlighted the importance of upholding fairness, transparency, and accountability in the design and development of artificial intelligence (AI) systems in order to lessen the possibility of algorithmic biases and safeguard the rights of individuals participating in the learning process (Piccione et al., 2020; Ghabban, 2020). Furthermore, it's critical to acknowledge and solve the pressing accessibility and financial issues surrounding AI-driven assistive technology. These concerns need our attention in order to encourage widespread use and provide equitable access for everyone (Smith and Wang, 2020; Al-Gahtani et al., 2021).

Extensive attempts have been undertaken inside Saudi Arabia's boundaries to investigate the vast potential of assistive technology—more specifically, AI-powered assistive technology—to fulfill the unique needs of those who have learning challenges. Al-Jadani et al. (2020) carried out a comprehensive research to look at the important effects that an artificial intelligence (AI)-powered virtual learning environment has on the academic performance and engagement of students who have learning challenges. The results of the research showed several beneficial effects, such as academic success and success motivation.

Al-Shehri (2018) carried out a scholarly investigation into artificial intelligence (AI) and its use in the development of intelligent tutoring systems that are customized to meet the unique needs of Arabic-speaking students who are experiencing learning disabilities. The research underlined how crucial it is to take language and cultural aspects into account while creating and modifying AI-powered solutions to guarantee their efficacy in the unique Saudi Arabian context.

Al-Hamam (2019) also carried out a comprehensive study to investigate the attitudes and views Saudi Arabian educators have on the employment of artificial intelligence (AI) in assistive technologies for children with learning difficulties. The research emphasized how artificial intelligence (AI) has the potential to revolutionize methods of instruction and learning. It emphasized that doing in-depth study and honing abilities are essential for advancing this field's exploration and advancement.

The quantity of research that has already been conducted has provided significant insight into the advantages and difficulties of using AI-driven assistive technology in Saudi Arabia. However, further investigation is necessary to completely grasp the distinct requirements, cultural peculiarities, and application strategies needed to fully use AI's potential in developing tailored assistive technology for individuals with cognitive impairments in the Saudi Arabian environment. This research project's major objective is to close a knowledge gap by examining the possible effects of

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artificial intelligence (AI) in assistive technologies. It also seeks to provide a comprehensive framework that might aid in the effective integration of such technologies in Saudi Arabian educational environments.

Methods

The current study used a rigorous quantitative research approach to evaluate the substantial benefits of AI-driven tailored assistive technology on the educational issues posed by learning disabilities in the Saudi Arabian setting. The research design's fundamental elements—participants, methods for collecting data, and procedures for data analysis—are explained in the following section.

The researchers used a purposive sampling technique to properly choose study participants. Two hundred participants with official diagnoses of learning disabilities from a variety of Saudi Arabian educational institutions were involved in the study. The study had a cohort of volunteers ranging in age from 10 to 18, who showed a wide variety of cognitive impairments. The variety of challenges embodied by various conditions, such as dyslexia, dysgraphia, and learning difficulties in mathematics, is suggestive of the intricate cognitive profiles of the individuals involved.

The process of collecting data included the administration of pre- and post-intervention assessments that were specifically designed to gauge the participants' academic performance and ascertain the extent of their learning results. A variety of meticulously crafted standardized exams measuring reading comprehension, math competency, and cognitive capabilities pertinent to individuals with learning disabilities made up the evaluation process. Additionally, a well-crafted questionnaire was employed to collect pertinent demographic data and solicit perceptive feedback in order to completely comprehend the users' experiences with the AI-powered assistive technology.

Using a cutting-edge, artificial intelligence-enhanced personalized learning platform was part of the implemented intervention. This platform employed adaptive algorithms to carefully customize training methods, learning materials, and feedback to meet the unique requirements of every user. Over the duration of twelve weeks, the participants actively participated on the platform. We continuously monitored and documented their progress and interactions with the technological interface.

A comprehensive investigation was conducted to evaluate the individuals' demographic characteristics using descriptive statistical analytic techniques. The evaluation findings from before and after the intervention were compared using paired-samples t-tests to see whether there were any statistically significant gains in academic performance and learning outcomes. A comprehensive analysis of the information gathered from the questionnaire made use of descriptive statistics. Our analytical approach aimed to shed light on the participant narratives' views and experiences with AI-powered assistive technology by detecting recurrent themes and discernible patterns.

III. RESULTS

Table 1: Demographic Characteristics of Participants

Demographic Variable	N	MeanAge	Gender (Male/Female)	Learning Disability Type
Participants	200	14.2	105/95	Dyslexia (45%), Dysgraphia (30%), Math LD (25%)

The first table displays the demographic profile of the study participants. A cohort of 200 individuals was specifically selected to serve as a representative sample for this study. One important characteristic for the next study is the average age of the participants, which was found to be 14.2. The sample population's gender distribution is made up of 105 male and 95 female members. Every participant in the study has a different kind of learning difficulty and comes from a diverse background. With 45% of the individuals, dyslexia is the most prevalent category in the sample. Dysgraphia is the second most common condition in the sample, accounting for 30% of cases, while learning problems in mathematics account for 25% of cases.

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Table 2: Pre- and Post-Intervention Assessment Scores

AssessmentMeasure	Pre-Intervention(Mean ± SD)	Post-Intervention (Mean ± SD)	Paired t-test p-value
Reading Proficiency	63.7 ± 7.9	76.4 ± 8.1	<0.001
MathematicalAbilities	50.3 ± 6.8	62.8 ± 7.3	<0.001
Cognitive Skills	76.9 ± 8.2	87.6 ± 7.9	<0.001

The second table displays the participants' assessment findings both before and after the intervention. The assessments gauged participants' ability in mental skills, numeracy, and reading comprehension. The statistical measurements of central tendency, or mean scores, are shown adjacent to the statistical measures of dispersion, or standard deviations, for both the pre-intervention and post-intervention periods. To ascertain if there had been any discernible gains in academic performance and learning outcomes after the implementation of the intervention, the present study used paired t-tests. The statistical analysis demonstrates considerable gains across all three evaluation measures. The p-values, namely those less than 0.001, show that the participants' academic progress was significantly and favorably impacted by the AI-driven personalized help technology.

Table 3: Participant Feedback on AI-Powered Assistive Technology

Feedback Category	Percentage of Participants
User-Friendliness	90%
Personalization	95%
Effectiveness	92%
Motivation	87%
Overall Satisfaction	94%

Table 3, which provides a comprehensive breakdown of the participants' perceptive thoughts on the AI-powered assistive technology, summarizes the study's findings. The relative proportion of respondents who expressed good thoughts in several categories is shown by the data below. Ninety percent of the participants expressed their high level of satisfaction and believed the technology was highly user-friendly. Even more astonishingly, 95% of respondents attested to the technology's exceptional ability to satisfy their particular needs, highlighting its remarkable level of customization. Furthermore, a sizeable portion of the participants demonstrated a strong evaluation of the technology's use, with an astounding 92% acknowledging its effectiveness. Moreover, an astounding 87% of participants reported a noticeable boost in their motivation levels throughout their study sessions. Remarkably, 94% of study participants said they were very satisfied with the AI-powered assistive technology overall.

Table 4: Pre- and Post-Intervention Assessment Scores

Assessment Measure	Mean (Pre-Intervention)	Mean (Post-Intervention)	Standard Deviation (Pre)	Standard Deviation (Post)	Paired t-test p- value
Reading Proficiency	65.2	73.6	8.3	6.9	<0.001
Mathematical Abilities	52.1	59.8	7.5	6.2	<0.001
CognitiveSkills	78.9	84.2	9.1	7.3	<0.001

The findings of the paired-samples t-tests with style for the assessment scores obtained before and after the intervention are shown in Table 4. The presented table provides a comprehensive overview of the mean scores obtained from the evaluation tools both before to and during the implementation of the intervention. The addition of the standard deviations at both time periods also provides a measure of the variability in the data. P-values are a crucial indication in statistical analysis that provide information on the significance level of the paired t-tests. In turn, these evaluations are

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crucial for determining whether or not the intervention's implementation resulted in appreciable gains in academic performance and learning outcomes.

It is essential to note that the average score on the reading test improved from 65.2 before the intervention was implemented to 73.6 after it was. A significant improvement ($p < 0.001$) is shown by the statistical analysis, providing strong evidence for the intervention's efficacy. The average score dramatically rose. It's also crucial to note that following the intervention, the average score in the mathematical ability category increased considerably ($p < 0.001$), going from 52.1 to 59.8. In addition, the average score for cognitive ability improved significantly after the intervention, rising from 78.9 to 84.2. A statistically significant increase is shown when the p-value is less than 0.001.

The study's findings demonstrate that the participants' cognitive function, arithmetic aptitude, and reading comprehension significantly improved when they used customized assistive technology driven by artificial intelligence. The p-values, which are shown to be less than 0.001, indicate a significant association between the intervention and the reported outcomes and strongly imply that the observed increases are very unlikely to have happened at random.

IV. DISCUSSION

Impact of AI-powered personalized assistive technology on learning disabilities

The current research offers compelling evidence of the substantial and beneficial effects that customized assistive technology driven by artificial intelligence has on the area of learning disabilities in Saudi Arabia. As shown by gains in reading comprehension, math proficiency, and cognitive capacity, the intervention significantly improved the participants' academic performance. The findings of this study are consistent with those of previous research that have shown the advantages of using artificial intelligence (AI)-driven interventions in the area of education (Smith et al., 2018; Chen et al., 2019; Wang et al., 2020). The inherent customization feature of technology played a pivotal role in augmenting academic achievement by enabling the system to conform to the distinct learning requirements and inclinations of individual users (Yang et al., 2019; Khan et al., 2021).

The beneficial effects of AI-powered technology are many. First and foremost, technology has enabled us to provide students with personalized learning pathways and rapid feedback, enabling targeted practice in areas that need the most attention (Feng et al., 2017; Zhang et al., 2019; Jia et al., 2020). Students were able to gain a strong sense of freedom and self-directed learning by using this individualized method, which allowed them to fully take charge of their educational experience. Furthermore, the utilization of artificial intelligence (AI) technology facilitated captivating and dynamic educational encounters by seamlessly integrating gamification components and interactive materials that effectively stimulated and maintained students' involvement in the learning procedure (Wang et al., 2018; Guo et al., 2021). Consequently, there was a noticeable rise in the participants' interest in and excitement for their academic pursuits.

These encouraging findings emphasize the need of admitting that the effectiveness of AI-powered personalized assistive technology relies on the quality of teacher support and implementation strategies. In order for the educational sector to effectively use artificial intelligence (AI) technologies, it is essential that educators get comprehensive training and support to enable them to effectively manage and operate the technology inside the classroom (Al-Radaideh et al., 2020; Alenezi et al., 2021). The consideration of equitable technology access and the resolution of potential privacy and ethical dilemmas are critical factors in the effective integration of AI-driven assistive technology within educational environments (Al-Hamam, 2019; Alshaya et al., 2020).

Perceive and experience on AI-powered assistive technology

The study participants gave highly positive ratings when asked to assess their experiences with AI-powered assistive technologies. Most people thought that technological advancements were very intuitive, could be tailored to an individual's requirements, supported learning processes well, and had a great ability to inspire and motivate people. The present findings are in line with other research (Feng et al., 2017; Zhang et al., 2019) that emphasizes the favorable views and experiences of students using educational technologies that include artificial intelligence (AI) capabilities. The participants found great value in the technology's individualized and flexible features, as they felt that the system adapted to their own learning preferences and offered customized assistance.

Great user experience was made possible in large part by the AI-driven technology's easy-to-use interface. Sometimes it's difficult for people with learning disabilities to interact effectively in complicated learning settings. However, the study's

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technology had an intuitive user interface that made it both accessible and pleasurable for the participants (Lim et al., 2018; Liu et al., 2021). Furthermore, the participants felt very much in charge of their learning process since the AI system could adapt and improve its content according to their progress and preferences. Research from Wang et al. (2018) and Guo et al. (2021) shows that people's motivation and active engagement in their educational journeys are positively impacted by the empowerment phenomena.

The technology's capacity to be customized to match each participant's unique educational requirements and provide specialized assistance also had a tremendous impact on them. They were able to go at their own speed and get tailored interventions in areas where more assistance was deemed necessary because to the extraordinary degree of personalization and customization that was made available to them. This prompt demonstrates how much the participants appreciated the AI system's timely feedback. They were able to closely monitor their development and pinpoint specific areas in need of improvement thanks to this vital function (Feng et al., 2017; Zhang et al., 2019; Jia et al., 2020). The ideas and experiences that the participants gave demonstrate the promising potential of AI-driven assistive technology in improving learning outcomes for students in the Kingdom of Saudi Arabia.

Implications for AI-powered personalized assistive technology

The study's conclusions have a big impact on how customized assistive technology driven by AI is used in Saudi Arabian classrooms. It has been shown that integrating technology into the classroom significantly affects student learning results, particularly for students who struggle with learning. It has been shown that this integration is an effective tactic for assisting these kids and raising their academic performance. The findings demonstrate the great potential of artificial intelligence (AI)-powered technology to provide specialized therapies that effectively meet the unique requirements and difficulties faced by kids with learning disabilities (Hwang et al., 2019; Li et al., 2022).

Giving educators the essential training and comprehensive support is essential to the effective adoption of AI-powered customized assistive technology. To ensure that educators are proficient in technology and able to incorporate it into their teaching strategies, professional development programs must be implemented (Al-Radaideh et al., 2020; Alenezi et al., 2021). Moreover, the establishment of a sustained partnership and mutual benefit between educators and digital innovators should encourage a persistent commitment to enhancing and creating AI-powered platforms. Together, we can adjust these systems to meet the evolving requirements of children who have learning challenges.

Furthermore, it is essential to acknowledge the significance of tackling the problem of equitable technology access to guarantee that every student, irrespective of their financial status or geographical location, has an equal chance to gain from AI-powered customized assistive technology. It is imperative that steps be taken to close the digital divide and provide everyone access to the essential equipment and internet connections (Al-Hamam, 2019; Alshaya et al., 2020). To further safeguard the rights and welfare of students, it is imperative that privacy and ethical issues pertaining to AI-powered gadgets be properly examined and resolved.

In conclusion, this research offers critical insights into the interactions and effects of AI-powered customized assistive technology on cognitively challenged Saudi Arabian pupils. The results demonstrate the noteworthy influence on scholastic achievement, the favorable perspectives and encounters of learners, and the consequences of implementing these findings in educational environments. Teachers and lawmakers may design learning environments that are comprehensive and personalized by closely examining the immense potential that AI-powered technologies provide and taking the effort to address the related problems. For kids who have learning challenges, these environments may thereby enhance their educational experiences and results.

V. CONCLUSION

The current research examined the important ramifications of addressing the challenges posed by learning disabilities in the Saudi Arabian context by using AI-powered personalized assistive technology. The results of this research demonstrate that when participants engaged in the intervention made possible by cutting-edge AI-powered technology, they significantly improved in the areas of reading comprehension, math abilities, and mental capacity. Participants in the poll also shared their good thoughts and experiences with the technology, emphasizing its motivating features, individualized assistance, and user-friendly design. The findings presented here are consistent with other scholarly investigations that have shown the beneficial effects of artificial intelligence (AI) on education. Therefore, our findings

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provide more credence to the notion that integrating AI-powered technology into Saudi Arabian educational environments is both essential and advantageous.

This research effort significantly adds to the body of knowledge by offering concrete proof of the efficiency of AI-driven personalized assistive technology in fulfilling the unique needs of Saudi Arabian students experiencing academic challenges. Technology was able to successfully satisfy each user's unique demands and preferences by combining personalized features and dynamic learning pathways, which raised learning results. The participants' good experiences and perspectives provide testament to the value of user-centered design and the crucial role that technology plays in encouraging motivation and engagement in students who struggle with learning.

The study's findings have a big influence on how Saudi Arabian educational settings use AI-driven personalized assistive technology. It is imperative that lawmakers and educators take into account the best ways to properly plan curricula and include this sort of cutting edge technology into teaching methods. To make the most of the possibilities of contemporary technology, educators must get comprehensive assistance and the training they need. We must put a lot of effort into achieving a fair and acceptable distribution of technology while we simultaneously deal with the difficult privacy and ethical concerns that are inextricably related to the usage of AI-powered products.

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