



The Role of Cognitive Flexibility in Adapting to Climate Change: AI-Driven Educational Strategies for Developing Adaptive Thinking

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ARTICLE INFO		ABSTRACT
Article History:		<i>This research explores the place of cognitive flexibility in strengthening adaptive thinking and problem-solving skills in response to climate change problems, and specifically highlights AI-powered education as an intervention tool to enhance such capabilities. Through a quantitative design, information was gathered from 180 Pakistani trainers and teachers using a self-administered questionnaire. The research applied correlation, multiple regression, and post hoc statistical tests to examine variable relationships. Results indicated a strong positive correlation between cognitive flexibility and decision-making ($r = 0.652$, $p < 0.01$) and problem-solving capacity ($r = 0.689$, $p < 0.01$). Furthermore, AI-based education positively predicted adaptive thinking skills acquisition ($\beta = 0.721$, $p < 0.01$, $R^2 = 0.612$), affirming its efficacy. However, post hoc analysis highlighted challenges in AI adoption, with less experienced educators perceiving greater barriers ($MD = 0.934$, $p < 0.001$). The study underscores the need for ethical AI integration, educator training, and policy support to enhance the effectiveness of AI in climate education. Future research should explore sustainable AI adoption models and interdisciplinary collaboration to maximize AI's role in fostering climate resilience.</i>
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1.0 Introduction

As climate change brings unprecedented challenges to the globe, there has never been a greater need for adaptive thinking and problem-solving. Cognitive flexibility, which involves the ability to change thinking and adapt to new, complex, or uncertain conditions, is instrumental in how people and societies address environmental change. Adaptability is key to making informed choices,

formulating sustainable solutions, and building resilience in the presence of climate-related disruptions. As AI continues to advance at a high speed, there can be crafted innovative education methods that increase cognitive flexibility to help people develop skills to handle and react effectively to climate-related issues. Educational software based on AI, such as adaptive learning platforms, personalized education, and simulation-based training, provides a flexible method for promoting critical thinking and problem-solving capacities in environmental sustainability. By merging AI with learning, students are able to learn from actual climatic situations, do predictive modeling, and acquire an in-depth appreciation of the interacting systems driving climate change. This study discusses the confluence of cognitive flexibility, AI-empowered education, and adaptation to climate change, pointing towards the potential for technology to enable a more robust and responsive society. By applying AI strategically in learning contexts, people can build their mental dexterity to predict, examine, and reduce the effects of climate change and contribute towards a sustainable future.

Climate change offers a major and persistent challenge for societies to innovate and respond efficiently. As the world's climate changes erratically, people and communities need to acquire the flexibility of thinking and come up with creative solutions. Cognitive flexibility as the capacity for mental switching from one concept to another and modifying in response to new information is essential in understanding the intricacies of climate change (Strielkowski et al., 2024). This competence allows one to examine changing environmental issues, make sound judgments, and adopt sustainable practices. In light of the fast development of artificial intelligence (AI), cognitive flexibility has the increasing potential of being boosted using AI-based pedagogical interventions. AI applications, including adaptive learning systems, immersive simulations, and data-backed feedback mechanisms, provide new approaches to building problem-solving skills and adaptive thinking capabilities (Chigbu et al., 2024). By incorporating AI in educational structures, students are able to deal with actual climatic situations, enhance their critical thinking skills, and develop adaptability in tackling climatic alterations. This article investigates the potential of cognitive flexibility to cope with climatic change and how education supported by AI is able to generate the desired capacity to create adaptive thinking and sustainable decision-making (George, 2023).

1.1 Cognitive Flexibility and Its Role in Climate Change Adaptation

Cognitive flexibility is a core component of human intelligence that enables people to modify their thinking, change frames of reference, and react suitably to novel situations. It is especially useful in the context of climate change, where problems are intricate, ambiguous, and continuously changing. According to research, people with high cognitive flexibility are more capable of interpreting environmental information, comprehending systemic connections, and creating creative solutions for sustainability (Das et al., 2025). Since climate change embodies complex issues—ranging from weather extremes to changes in biodiversity—societies need to depend on agile thinkers who have the ability to synthesize pluralistic viewpoints and cross-disciplinary knowledge to develop solutions to the problems. Cognitive flexibility also engenders resilience as it allows the individual to accommodate environmental stressors and adaptability to new technologies, policies, and lifestyle transformation necessary for sustainable development (Halkiopoulos & Gkintoni, 2024). This introduction emphasizes the importance of cognitive flexibility for adapting to climate change and calls for developing this ability within education and policy-making (Chauncey & McKenna, 2024).

1.2 The Potential of AI-Driven Educational Strategies in Enhancing Adaptive Thinking

Artificial intelligence has revolutionized the world of learning by implementing tailored learning experiences, simulation exercises, and immediate feedback loops that align with personal cognitive requirements. Educational approaches enabled through artificial intelligence have the capacity to augment cognitive flexibility by presenting students with varying outlooks, compound problem-solving challenges, and fluctuating environmental situations (Aggarwal, 2023). For instance, adaptive learning systems driven by AI examine the cognitive patterns of students and present them with learning materials that engage their thought processes. Moreover, AI-driven simulations can place learners in actual climate crisis situations where they have to evaluate data, forecast outcomes, and come up with solutions, thus improving their critical thinking and flexibility (Samuel et al., 2023). In addition, AI technologies like intelligent tutoring systems and machine learning algorithms can measure students' level of adaptability and offer individualized interventions to enhance their cognitive flexibility. With the use of AI in education, institutions can empower individuals with the skills they need to meet climate challenges with flexibility and innovation, developing a generation of problem-solvers for a fast-paced world (Chauncey & McKenna, 2023).

1.3 AI-Driven Programs for Developing Cognitive Flexibility in Climate Change Education

Several artificial intelligence-based tools have already been shown to have success in generating cognitive flexibility through climate change learning. A classic example is how virtual reality (VR) and AI-based simulation can be employed to design intensive learning environments with real-time climate scenario decision-making challenges for learners (Al Fraidan, 2024). Software like NASA's Earth Science AI platforms employs big data analysis and AI-based models to enable students and researchers to see climate change trends and interactively explore solutions. AI-based educational platforms like IBM Watson and Google's DeepMind have also been incorporated into environmental science curricula to enable individualized learning streams that boost problem-solving and adaptive thinking (Mustafa et al., 2024). These case studies bring to the fore the efficiency of AI-based tools in developing cognitive flexibility, showing how technology can be used to enhance learning outcomes on climate adaptation (Bharathi et al., 2024).

1.4 AI Driven Tools for Climatic Change

Artificial intelligence (AI) is increasingly pivotal in addressing climate change through advanced predictive modeling, resource optimization, and real-time environmental monitoring. Machine learning algorithms analyze vast datasets from satellite imagery to atmospheric sensors to forecast extreme weather events, track carbon emissions, and identify deforestation patterns with unprecedented precision. AI-driven tools also enhance renewable energy systems by optimizing grid efficiency, predicting solar/wind output, and reducing waste in energy distribution. In agriculture, smart AI models enable climate resilient farming by advising on crop rotation, water usage, and soil health tailored to shifting climatic conditions (Shah, 2023). These technologies empower policymakers and scientists to design data informed mitigation strategies, accelerate carbon capture innovations, and promote global sustainability goals. By integrating AI with climate science, stakeholders can bridge the gap between theoretical research and actionable solutions, fostering scalable interventions to combat one of humanity's most pressing challenges.

1.5 Challenges and Ethical Considerations in AI-Driven Climate Change Education

Although AI presents bright prospects to improve cognitive flexibility in climate change education, there are some challenges and ethical concerns to be overcome. Among them is the issue of the digital divide, as access to AI-based learning tools is still uneven between various socio-economic classes and regions (Ezzaim et al., 2024). Besides, AI systems need enormous amounts of data, which creates threats to privacy, prejudice, and the appropriate utilization of information. Algorithms can inadvertently perpetuate existing biases in climate knowledge sharing, which can limit diverse views in problem-solving strategies (Gligorea et al., 2023). There is also the risk of excessive reliance on AI technologies, which can lower human agency in decision-making and critical thinking. To fully realize the potential of AI-based education, ethical guidelines and policies need to be established to facilitate fair access, transparency, and responsible usage of AI tools in learning for climate adaptation (Al Fraidan, 2024).

1.6 Research Objectives

The main research objectives of the study are;

- **To explore** how cognitive flexibility enhances adaptation to climate change through decision-making and problem-solving.
- **To assess** the effectiveness of AI-driven education in developing adaptive thinking for climate challenges.
- **To evaluate** the challenges and ethical considerations of AI integration in climate education.

1.7 Research Questions

- What role does cognitive flexibility play in improving decision-making and problem-solving abilities in individuals adapting to climate change?
- To what extent does AI-driven education foster adaptive thinking and problem-solving skills that are crucial for addressing climate challenges?
- What are the key challenges and ethical issues involved in integrating AI technologies into climate education, and how do these impact their effectiveness and acceptance?

1.8 Problem Statement

Climate change presents complex and unpredictable challenges that require individuals to think adaptively and develop innovative solutions. However, traditional education systems often fail to cultivate cognitive flexibility, a crucial skill for navigating uncertainty and making informed decisions in response to environmental changes. With the rise of artificial intelligence (AI), there is an opportunity to enhance learning experiences through personalized, interactive, and data-driven educational strategies. Despite this potential, the effectiveness of AI-driven education in fostering adaptive thinking for climate change adaptation remains underexplored. Additionally, ethical concerns, accessibility issues, and the risk of over-reliance on AI pose challenges to its implementation. This research aims to address these gaps by examining the role of cognitive flexibility in climate adaptation, assessing AI-driven strategies for enhancing adaptive thinking, and evaluating potential limitations to ensure equitable and responsible use of AI in education.

1.9 Significant of the Study

This study is significant as it highlights the critical role of cognitive flexibility in adapting to climate change and explores how AI-driven educational strategies can enhance adaptive thinking. By examining the intersection of cognitive science, artificial intelligence, and climate education, this research provides valuable insights into innovative learning approaches that prepare individuals for complex environmental challenges. The findings can contribute to the development of more effective and responsive educational frameworks, equipping learners with the problem-solving skills needed for sustainable decision-making. Additionally, this study addresses ethical and accessibility concerns associated with AI in education, ensuring that technological advancements are implemented equitably. Ultimately, this research supports policymakers, educators, and AI developers in creating inclusive, effective, and future-ready climate education strategies.

2.0 Literature Review

2.1 Cognitive Flexibility and Its Importance in Climate Adaptation

Cognitive flexibility refers to the capacity to change modes of thinking, adapt to new data, and generate multiple approaches for solving multifaceted problems. It is significant in human resilience, especially under climate change conditions, where individuals have to negotiate uncertain environmental, economic, and social pressures. Studies have shown that cognitive flexibility improves problem-solving skills by enabling one to tackle climate problems from interdisciplinary angles, promoting creativity and innovation (Yuldashev et al., 2024). Psychological and neuroscience studies have established that people with greater cognitive flexibility are more resilient in dealing with uncertainty, hence better placed to embrace sustainable practices and policies (Kucuksuleymanoglu, 2025). In addition, cognitive flexibility enhances long-term thinking necessary for adopting climate adaptation strategies that meet both current needs and future environmental sustainability (Shah, 2023). As such, incorporating the development of cognitive flexibility in education can enable people to make adaptive, informed decisions regarding climate change.

Artificial intelligence has transformed the education industry through personalized learning experiences, data insights, and interactive learning environments. AI-based learning tools have been shown to improve adaptive thinking by adapting content to specific cognitive requirements, encouraging critical reasoning, and developing complex problem-solving abilities (Khotimah & Rusijono, 2024). AI-based adaptive learning systems review the learning habits of students, real-time modify their teaching methods, and give feedback to enhance their cognitive flexibility (Yekollu et al., 2024). Computer-based simulations and AI-enabled interactive interfaces enable learners to access actual climate change contexts, enhancing their capacity to predict, analyze, and forestall environmental threats (Strielkowski et al., 2024). Moreover, AI technologies like intelligent tutoring systems and machine learning algorithms offer customized evaluations tailored towards developing resilience and critical thinking abilities in uncertain situations. Such innovations illustrate the ability of AI in cognitive skills development for climate adaptation, propelling the call for its incorporation into educational models (ElMaraghy & ElMaraghy, 2022).

2.2 AI-Driven Climate Change Education: Case Studies and Applications

Several educational programs have successfully utilized AI-driven tools to improve climate literacy and adaptive thinking. For example, NASA's Earth Science AI platforms use big data

analytics to help students visualize climate patterns and understand environmental changes through interactive learning (Tariq, 2024). Similarly, AI-powered platforms like Google's DeepMind and IBM Watson have been integrated into climate science education, providing personalized content and problem-solving exercises based on real-time climate data (Vorsah & Oppong, 2024). Additionally, virtual reality (VR) and AI-based simulations allow learners to immerse themselves in climate change scenarios, requiring them to analyze data, make policy decisions, and evaluate environmental impacts. These case studies highlight the potential of AI-driven education in fostering cognitive flexibility, demonstrating how technology can prepare individuals to respond effectively to climate change. However, while AI enhances learning experiences, further research is needed to evaluate its long-term impact on cognitive adaptability and decision-making in real-world climate challenges (Rane et al., 2024).

Despite AI's potential in education, several challenges and ethical concerns must be addressed before widespread implementation. One significant challenge is the digital divide, as access to AI-driven educational tools remains uneven across different socio-economic and geographical regions (Sandhu et al., 2024). This disparity can hinder equitable learning opportunities, exacerbating existing inequalities in climate education. Also, AI systems are dependent on huge datasets, and this raises issues of privacy, security, and bias in learning materials (Nehru et al., 2025). Unless AI-based learning models are well-designed, they can perpetuate biases in climate knowledge sharing, constraining diverse viewpoints in solving problems. Another issue is overdependence on AI, which can limit learners' capacity to think and decide independently. Ethical implications have to be addressed in order to guarantee that AI in climate education supports inclusivity, transparency, and responsible learning. Overcoming these challenges will be essential to maximizing the use of AI-led approaches to supporting cognitive flexibility and climate adaptation.

2.3 The Need for AI Integration in Cognitive Flexibility Development

With the increasing complexity of climate change, there is a pressing need for educational strategies that develop cognitive flexibility and adaptive thinking. AI-based education offers a potential solution by providing personalized, data-driven, and immersive learning experiences that promote problem-solving capabilities. But for this to be successful, challenges in accessibility, ethics, and responsible use of AI must be addressed (Fu & Chow, 2017). Future studies need to strive for enhancing AI-based learning models to ensure that they accommodate learning diversity while upholding ethical requirements. By incorporating AI into climate education systems, societies are better positioned to equip the populace with cognitive flexibility in order to respond and adapt to environmental uncertainties more effectively.

2.4 Research Gap

While existing research highlights the importance of cognitive flexibility in problem-solving and the potential of AI-driven education in enhancing learning experiences, there is a significant gap in understanding how AI can specifically foster adaptive thinking for climate change adaptation. Most studies focus on AI's role in personalized learning and decision-making but do not explicitly address its application in developing the cognitive skills necessary for navigating complex environmental challenges. Additionally, research on AI-driven climate education often overlooks ethical concerns, accessibility issues, and the risk of cognitive over-reliance on technology. There is also limited empirical evidence on the long-term effectiveness of AI in enhancing cognitive flexibility and decision-making in real-world climate adaptation scenarios. This gap underscores the need for further exploration of AI-integrated educational strategies that not only improve

cognitive flexibility but also ensure equitable, ethical, and sustainable implementation in climate education.

2.5 Hypothesis

1. **H₁:** There is a significant relationship between cognitive flexibility and individuals' ability to adapt to climate change through effective decision-making and problem-solving.
2. **H₂:** There is a significant impact of AI-driven education on the development of adaptive thinking and problem-solving skills for addressing climate challenges.
3. **H₃:** There are significant challenges and ethical considerations affecting the integration of AI in climate education, influencing its accessibility and effectiveness.

3.0 Methodology

3.1 Research Design

This study was based on a quantitative research design, aiming to statistically analyze the relationship between cognitive flexibility, AI-driven education, and adaptive thinking in climate change education. A structured and systematic approach was used to collect numerical data, test hypotheses, and establish generalizable findings. By employing a survey-based methodology, the study ensured objective and measurable results that contributed to understanding the impact of AI-driven education on cognitive adaptability.

3.2 Population and Sample Size

The target population for this study was educators and trainers specializing in climate change education, environmental studies, or behavioral sciences across Pakistan. This group was selected due to their direct involvement in climate-related education and their ability to provide insights into AI integration in teaching. A sample size of 180 respondents was drawn from this population to ensure sufficient representation and statistical reliability.

3.3 Sampling Technique

The study employed probability sampling techniques, allowing every individual in the target population to have an equal chance of being selected. Specifically, stratified random sampling was used to ensure representation across various academic disciplines, institutional types, and geographic locations within Pakistan. This approach enhanced the validity of findings by reducing selection bias and ensuring diversity in perspectives.

3.4 Data Collection Method

Primary data were collected using a **self-administered questionnaire**, which was designed to assess cognitive flexibility, AI-driven education experiences, and perceptions of climate adaptation skills. The questionnaire included the following sections:

- **Demographic Information:** Captured details such as age, academic background, and years of teaching experience.

- **Cognitive Flexibility Scale:** Measured adaptability in decision-making and problem-solving.
- **AI-Driven Education Scale:** Assessed exposure to and perceptions of AI-enhanced teaching tools.
- **Climate Adaptation Thinking Scale:** Evaluated problem-solving and critical thinking in climate-related contexts.

The questionnaire was distributed electronically through academic networks, online survey platforms, and institutional collaborations to ensure a wide reach among participants.

3.5 Data Analysis Techniques

The collected data were analyzed using the following statistical techniques:

- **Descriptive Statistics:** Used to summarize demographic data, including frequencies, means, and standard deviations.
- **Correlation Analysis:** Conducted to determine the strength and direction of relationships between cognitive flexibility, AI-driven education, and climate adaptation skills.
- **Regression Analysis:** Used to assess the predictive impact of AI-driven education on the development of adaptive thinking and problem-solving abilities.
- **Post Hoc Statistical Tests:** Performed to compare differences across subgroups, ensuring robustness in the findings.
- **Reliability and Validity Tests:** Conducted to ensure the accuracy and consistency of the measurement scales used in the questionnaire.

All statistical analyses were conducted using **SPSS or similar statistical software**, ensuring accuracy and reliability in the interpretation of results. This methodological approach ensured that the study produced empirical, data-driven insights into the role of AI in enhancing cognitive flexibility for climate change adaptation.

4.0 Data Analysis

The data analysis in this study was conducted to examine the relationship between cognitive flexibility, AI-driven education, and adaptive thinking in climate change adaptation. Various statistical techniques were applied to ensure a comprehensive understanding of the collected data. Descriptive statistics were used to summarize demographic information, while correlation analysis identified the strength and direction of relationships between key variables. Regression analysis was performed to assess the predictive impact of AI-driven education on cognitive flexibility and problem-solving abilities. Additionally, post hoc statistical tests were conducted to compare differences across subgroups, ensuring the robustness of the findings. Reliability and validity tests were also carried out to confirm the accuracy and consistency of the measurement scales used in the questionnaire. By employing these analytical methods, the study provided empirical insights into how AI-driven education can enhance cognitive flexibility and adaptive decision-making for climate change adaptation.

Table 1: Demographic Characteristics of Respondents (Sample Size 180)

Demographic Variable	Categories	Frequency (N = 180)	Percentage (%)
Gender	Male	98	54.4%
	Female	82	45.6%
Age Group	20-30 years	45	25.0%
	31-40 years	72	40.0%
	41-50 years	38	21.1%
	51 years and above	25	13.9%
Academic Qualification	Bachelor's Degree	40	22.2%
	Master's Degree	85	47.2%
	Ph.D.	55	30.6%
Years of Teaching Experience	Less than 5 years	50	27.8%
	5-10 years	65	36.1%
	11-20 years	40	22.2%
	More than 20 years	25	13.9%
Field of Expertise	Environmental Studies	78	43.3%
	Behavioral Science	50	27.8%
	Climate Education	52	28.9%

The data analysis that tested the hypotheses gave valuable information on the association between cognitive flexibility, AI education, and adaptive thinking in climate change adaptation. Correlation analysis showed a high positive association between cognitive flexibility and adaptive decision-making, which proved that people with greater cognitive flexibility were more effective in solving climate issues. Multiple regression analysis also supported the fact that AI-based education strongly predicted the enhancement of adaptive thinking and problem-solving abilities, reinforcing the hypothesis that AI-based education increases cognitive adaptability. Further, post hoc statistical tests established significant differences across different educator groups depending on experience and area of expertise, meaning that the efficiency of AI-based education differed in different groups. In general, the results confirmed the hypotheses of the study, underscoring the essential contribution of AI-boosted education in promoting cognitive flexibility for climate adaptation while pointing to possible challenges and inequalities in its application.

Table 2: Correlation Analysis for H_1

Variables	Mean	SD	Cognitive Flexibility (r-value)	p-value	Significance
Cognitive Flexibility	4.21	0.65	1.00	-	-
Decision-Making in Climate Adaptation	4.05	0.72	0.652	0.000	Significant
Problem-Solving Ability	3.98	0.78	0.689	0.000	Significant

The correlation analysis shows a strong positive relationship between cognitive flexibility and both decision-making ($r = 0.652$, $p < 0.01$) and problem-solving ability ($r = 0.689$, $p < 0.01$). Since the p-values are below 0.05, the results confirm a significant relationship, supporting H_1 .

Table 3: Multiple Regression Analysis for H_2

Predictor Variables	β (Beta Coefficient)	t-value	p-value	Significance
AI-Driven Education	0.721	7.93	0.000	Significant
Training in AI-Based Learning	0.589	6.45	0.001	Significant
Perceived Usefulness of AI	0.648	7.02	0.000	Significant
R^2	0.612	-	-	-
Adjusted R^2	0.605	-	-	-
F-Statistic	42.87	-	0.000	Significant

The regression analysis verifies that AI-based education significantly contributes to the growth of adaptive thinking and problem-solving skills for solving climate issues. The β coefficient (0.721, $p < 0.01$) signifies that AI-based learning significantly predicts adaptive thinking. Moreover, training in AI-learning ($\beta = 0.589$, $p < 0.01$) and perceived ease of using AI ($\beta = 0.648$, $p < 0.01$) play a crucial role in facilitating people's capability to think adaptively in climatic situations. The R^2 of 0.612 indicates that education in AI accounts for 61.2% of the variance in adaptive problem-solving abilities, implying its efficacy in developing cognitive flexibility. High F-statistic value (42.87, $p < 0.01$) supports overall significance of the model. Results concur with H_2 in corroborating the proposal that AI-enhanced learning has an increasing influence on adaptive thinking and climate change adaptation decision-making.

Table 4: Post Hoc Analysis (Tukey HSD) for H_3

Comparison Groups	Mean (MD)	Difference Standard Error (SE)	Error p-value	Significance
Environmental Studies vs. Behavioral Science	0.782	0.145	0.002	Significant
Environmental Studies vs. Climate Education	0.523	0.136	0.018	Significant
Behavioral Science vs. Climate Education	0.259	0.142	0.082	Not Significant
Less than 5 years vs. 5-10 years' Experience	0.618	0.157	0.006	Significant
Less than 5 years vs. 11-20 years' Experience	0.845	0.162	0.001	Significant
Less than 5 years vs. More than 20 years	0.934	0.168	0.000	Significant
5-10 years vs. 11-20 years' Experience	0.384	0.149	0.059	Not Significant
5-10 years vs. More than 20 years	0.576	0.155	0.009	Significant
11-20 years vs. More than 20 years	0.217	0.138	0.095	Not Significant

Post hoc analysis with Tukey HSD indicates significant differences in the perception of challenges in integrating AI in climate education between fields and levels of experience. Teachers in Environmental Studies indicated significantly greater concerns regarding AI accessibility and ethics than those in Behavioral Science ($MD = 0.782, p < 0.01$) and Climate Education ($MD = 0.523, p < 0.05$). In addition, teachers with less than 5 years of teaching experience found more challenges than those with 5-10 ($MD = 0.618, p < 0.01$), 11-20 ($MD = 0.845, p < 0.01$), and over 20 ($MD = 0.934, p < 0.001$) years of experience. Yet, differences among Behavioral Science and Climate Education ($p = 0.082$) and 11-20 years and >20 years ($p = 0.095$) were statistically insignificant. The findings validate H_3 , thereby affirming ethical concerns and problems of AI in climate education as differing considerably on the basis of educators' proficiency and experience level.

5.0 Results and Findings

The research findings in this study offer important understanding of the role that cognitive flexibility, AI-based learning, and adaptive thought play in meeting climate change challenges. The research confirms that cognitive flexibility is important in improving decision-making and problem-solving abilities, as noted by earlier studies emphasizing its role in coping with dynamic and uncertain contexts (Laak & Aru, 2024). The positive correlation ($r = 0.652, p < 0.01$) between decision-making and cognitive flexibility supports previous research by (Chigbu et al., 2024), which indicated that people with higher cognitive flexibility exhibit better problem-solving skills when confronted with environmental challenges. These results support the need to incorporate cognitive training into climate education curricula to make people better equipped to deal with intricate ecological and socio-political shifts.

The analysis revealed notable disparities in educators' perceptions of AI integration challenges in climate education, shaped by disciplinary backgrounds and professional tenure. Post hoc comparisons demonstrated that Environmental Studies instructors expressed significantly heightened concerns about AI's ethical implications and accessibility barriers compared to peers in Behavioral Science ($M\Delta = 0.782, p < 0.01$) and Climate Education ($M\Delta = 0.523, p < 0.05$). Furthermore, educators with under five years of experience reported greater challenges than their more seasoned counterparts across all experience brackets (e.g., $M\Delta = 0.934, p < 0.001$ for >20 years), suggesting that novice educators may grapple more acutely with AI's technical and pedagogical demands. However, differences between Behavioral Science and Climate Education disciplines ($p = 0.082$) and between mid-career (11–20 years) and veteran (>20 years) educators ($p = 0.095$) lacked statistical significance, indicating shared concerns within these subgroups. Findings; These results corroborate H_3 , highlighting how ethical and operational apprehensions toward AI in climate education are mediated by educators' disciplinary expertise and experiential familiarity, underscoring the need for tailored training programs aligned with these contextual factors.

5.1 Discussion

Additionally, the research offers empirical evidence in favor of the critical contribution of AI-powered education towards the development of adaptive thinking. The regression analysis ($\beta = 0.721, p < 0.01, R^2 = 0.612$) verifies that AI-powered learning environments have a positive effect on individuals' capacity to acquire problem-solving skills for climate adaptation. These findings agree with prior research that has indicated the capability of AI-powered learning to increase critical thinking and flexibility (Arán Filippetti & Krumm, 2020). AI-powered learning platforms provide adaptive learning, real-time analytics, and simulation-based interactive training, all of

which aid in developing adaptive cognitive abilities. Past research by (Güner & Gökçe, 2021) highlights that AI can play a great role in enhancing learning engagement and knowledge retention, complementing the findings of this research further. This research, thus, contributes to past research by offering quantitative evidence on how AI-based education directly enhances climate-related decision-making abilities.

However, the research also finds notable challenges and ethical issues in AI integration in climate education. The post hoc analysis ($MD = 0.782$, $p < 0.01$) indicates that Environmental Studies teachers feel more challenges in terms of AI accessibility and ethical issues than teachers in other disciplines. This result is consistent with earlier research by (Williams et al., 2019), which contends that AI adoption in education is frequently slowed down by data privacy concerns, algorithmic bias, and disparate access to AI-based resources. Furthermore, less experienced teachers (those with fewer than five years of experience) indicated significantly higher concerns compared to their more experienced peers ($MD = 0.934$, $p < 0.001$). This is in line with research by (Kulkov et al., 2024), which posits that inexperienced teachers can face challenges in the adoption of AI because they lack training and experience with new technologies. These findings underscore the significance of teacher education programs and policy controls to provide ethical and inclusive AI adoption for climate education (Walker et al., 2022).

In addition, the research adds to the existing literature by showing not only that AI-based education is effective in fostering problem-solving and adaptive thinking capabilities, but also that it has systemic issues that must be tackled. According to Luckin et al. (2021), AI in education needs to be deployed with ethical considerations to avoid algorithmic bias and digital divide issues. This research supports such assertions by presenting empirical evidence regarding the differences in AI accessibility and awareness among various groups of educators (Leung, 2014).

5.1 Conclusion

In conclusion, the findings of the study concur with existing literature that attests to the significance of cognitive flexibility in climate adaptation, the efficacy of AI-based education in developing adaptive capacities, and the limitations of AI adoption in education. The findings indicate that although AI-based learning holds tremendous potential to improve climate resilience, systemic impediments such as ethical issues, training deficits, and accessibility need to be overcome. Subsequent research should investigate policymaking approaches, teacher training modules, and balanced AI adoption models to optimize the impact of AI on climate education. In conclusion, the findings of the study concur with existing literature that attests to the significance of cognitive flexibility in climate adaptation, the efficacy of AI-based education in developing adaptive capacities, and the limitations of AI adoption in education. The findings indicate that although AI-based learning holds tremendous potential to improve climate resilience, systemic impediments such as ethical issues, training deficits, and accessibility need to be overcome. Subsequent research should investigate policymaking approaches, teacher training modules, and balanced AI adoption models to optimize the impact of AI on climate education (Ng et al., 2023).

This research emphasizes the importance of cognitive flexibility in facilitating decision-making and problem-solving in climate change adaptation, with special emphasis on the immense contribution of AI-based education in adaptive thinking. The research validates that the higher the cognitive flexibility, the more capable individuals are of responding to climate-related issues, and AI-based learning platforms efficiently increase these cognitive functions. But the research also discloses significant challenges and ethical concerns, such as unequal access to AI, algorithmic bias, and the requirement of proper educator training. These findings are in consonance with past research, underscoring the importance of responsible integration of AI in climate education to provide equal access and compliance with ethics. Subsequent studies must center on policy environments, training programs, and fair AI deployment to achieve its optimal contribution to climate resilience and adaptive learning.

5.2 Recommendations

1. **Enhance cognitive flexibility training** integrate cognitive flexibility exercises into climate education programs.
2. **Expand AI-Driven Learning Tools** develop AI-based platforms tailored to climate problem-solving.
3. **Improve educator training** provide AI-focused training for teachers to enhance implementation.
4. **Ensure Ethical AI Integration** address algorithmic bias and data privacy concerns in AI-driven education.
5. **Promote Accessibility Bridge** the digital divide by ensuring equal access to AI educational resources.
6. **Encourage policy development** implement regulations to guide responsible AI use in education.
7. **Increase interdisciplinary collaboration** foster partnerships between educators, policymakers, and AI experts.
8. **Support further research** conduct longitudinal studies on AI's long-term impact on adaptive thinking.

5.4 Future Research

This research is an endeavour towards the gap finding. However, future studies could extend these findings by investigating the underlying drivers of disciplinary and experiential disparities in educators' perceptions of AI integration. For instance, qualitative inquiries might explore why Environmental Studies educators prioritize ethical and accessibility concerns more acutely than peers in Behavioral Science or Climate Education, potentially uncovering discipline specific pedagogical values or institutional constraints. Additionally, longitudinal research tracking educators evolving attitudes as they gain AI related training or experience could clarify whether apprehensions diminish with targeted professional development. The nonsignificant differences between mid-career and veteran educators suggest the need for larger, cross cultural samples to determine if this trend reflects universal patterns or contextual factors. Further, experimental designs could test tailored interventions such as ethics focused AI workshops for Environmental Studies educators or technical upskilling programs for early career teachers to mitigate identified challenges. Finally, interdisciplinary collaborations between AI developers and educators could refine tools that align with sector specific needs, bridging gaps between technological innovation and classroom applicability. Such research would advance equitable, context aware strategies for integrating AI into climate education while addressing ethical and operational barriers.

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