



Analyzing the Effect of Chatbots, Voice Assistants, And Learning Apps on Metacognition: A Quantitative Approach

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Abstract

This study investigates the impact of various Artificial Intelligence (AI) based tools on the development of metacognitive skills among young adults, specifically focusing on dimensions such as planning, monitoring, self-regulation, and reflection. A quantitative research design was employed using structured interview schedules and a standardized Metacognitive Skills Scale to collect data from a purposive sample of 200 participants aged 18–35. Participants were categorized based on their primary AI tool usage: chatbots, voice assistants, learning applications, and visual AI tools. Findings revealed that learning apps (51%) and visual AI tools (26.5%) were the most commonly used, primarily for academic purposes (64%). A significant proportion of participants (62.5%) reported improved learning outcomes, and 60.5% perceived enhanced academic performance attributed to AI usage. ANOVA results indicated statistically significant differences in metacognitive scores among AI tool categories ($F = 3.67, p = 0.013$), with learning applications and visual AI tools associated with higher levels of metacognitive engagement. The study concludes that active, interactive, and feedback-driven AI tools are more effective in fostering metacognitive skill development compared to passive interfaces like chatbots and voice assistants. These findings underscore the potential of AI to promote self-regulated learning and emphasize the importance of digital literacy to harness its educational benefits effectively.

Keywords: Metacognition, artificial intelligence, chatbots, learning apps, self-regulated learning

Introduction

In recent years, the integration of Artificial Intelligence (AI) technologies into education has transformed traditional learning environments, offering new avenues for personalized, interactive, and self-paced learning (Zawacki-Richter *et al.*, 2019) [4]. Among the most prominent AI tools adopted by learners are chatbots, voice assistants, learning applications, and visual AI tools (Luckin *et al.*, 2016) [3]. These technologies are increasingly accessible and are often embedded in mobile devices, e-learning platforms, and productivity tools, thereby influencing students' cognitive and metacognitive behaviors (Holmes *et al.*, 2019) [1]. Metacognition, defined as the awareness and regulation of one's own thinking processes, plays a critical role in effective learning. It encompasses higher-order skills such as planning, monitoring, self-regulation, and reflection, which are essential for academic achievement and lifelong learning. As digital tools become more prevalent, understanding how they influence these cognitive domains is imperative (Ifenthaler & Yau, 2020) [2]. AI-powered tools, through features such as real-time feedback, personalized content, and interactive learning pathways, have the potential to support and enhance metacognitive development (Roll & Wylie, 2016; Wong *et al.*, 2022) [5, 6]. While prior research has explored the pedagogical benefits of educational technology, limited empirical studies have focused specifically on the comparative effects of different AI tools on metacognitive skills. This study addresses this gap by examining the relationship between AI tool usage and metacognitive ability among young adults aged 18–35. Using a structured interview schedule and a standardized Metacognitive Skills Scale, the research categorizes participants based on their primary AI tool usage and assesses the impact of these tools on core metacognitive

domains. The study also explores usage patterns and user perceptions, revealing that learning applications and visual AI tools are more frequently employed for academic purposes and are associated with higher reported improvements in learning outcomes. Statistical analysis (ANOVA) demonstrates significant variation in metacognitive scores across different AI tool groups, suggesting that interactive and feedback-rich tools may foster better self-regulation and reflective practices. By systematically analyzing how AI tools contribute to metacognitive development, this research aims to inform educators, technologists, and policymakers about the potential of AI in promoting self-directed learning and the critical need for digital literacy to maximize its educational impact.

Methodology

This study adopted a quantitative, cross-sectional research design to examine the influence of various Artificial Intelligence (AI) tools on the metacognitive skills of young adults. The approach enabled a systematic evaluation of patterns and relationships between AI tool usage and dimensions of metacognition, including planning, monitoring, self-regulation, and reflection.

Research Design

The study employed a quantitative, descriptive, and cross-sectional research design to explore the relationship between the use of AI tools and metacognitive abilities. This design allowed for the collection of data at a single point in time from a diverse group of individuals to identify trends, relationships, and group differences. A correlational approach was also embedded to determine the strength of association between tool usage and metacognitive scores.

Sample Selection

The sample for this study was selected using a purposive sampling technique, targeting individuals who actively use AI-based tools for learning or academic-related tasks. This non-probability sampling method was chosen to ensure that the participants had sufficient exposure to AI tools such as chatbots, voice assistants, learning applications, and visual AI tools making them suitable respondents for assessing metacognitive impacts (Etikan, Musa, & Alkassim, 2016) [7].

A total of 200 young adults, aged between 18 to 35 years, were included in the study. The age range was selected to capture a population that is both technologically engaged and in the active stages of academic, professional, or skill-development pursuits. Participants were recruited from universities, online learning platforms, and digital learning communities.

Tools for Data Collection

Two primary tools were employed for data collection in this study: a structured interview schedule and a standardized Metacognitive Skills Scale. The structured interview schedule was developed together detailed demographic information, patterns of AI tool usage, and the purposes for which participants used these tools such as academic learning, skill development, or general knowledge enhancement. It also included questions to identify the specific category of AI tool each participant used most frequently: chatbots, voice assistants, learning applications, or visual AI tools. The responses enabled the classification of participants into relevant comparison groups for analysis. In addition to this, the Metacognitive Skills Scale was used to assess the participants’ levels of metacognitive functioning. This standardized scale measured four core dimensions of metacognition: planning, monitoring, self-

regulation, and reflection. Comprising 25 items rated on a five-point Likert scale (ranging from 1 = strongly disagree to 5 = strongly agree), the scale has been validated in previous studies and showed high internal consistency (Cronbach’s alpha > 0.80) in the current study as well. Together, these tools provided comprehensive and reliable data to evaluate the influence of AI-based tools on metacognitive development in young adult learners.

Data Collection Procedure

The data collection process was carried out over a period of four weeks using both online and offline modes to ensure broad participation and convenience. Prior to data collection, ethical approval was obtained from the relevant institutional review board, and informed consent was secured from all participants. An initial briefing was provided to explain the study’s objectives, voluntary nature of participation, and confidentiality of responses (Creswell & Poth, 2018) [8]. Participants meeting the inclusion criteria were identified through university networks, educational platforms, and social media forums. The structured interview schedule and the Metacognitive Skills Scale were administered either in-person or via secure digital forms (e.g., Google Forms). Each participant was asked to report their most frequently used AI tool, which determined their classification into one of four user groups: chatbots, voice assistants, learning applications, or visual AI tools. On average, the completion of the full questionnaire took approximately 20–30 minutes. The researchers monitored the process to address any participant queries and to ensure complete and accurate responses. Data were collected anonymously and securely stored to maintain participant privacy and to comply with ethical research standards. Upon completion, the data were systematically organized and coded for statistical analysis using SPSS software.

Table 1: Participant Profile (N = 200)

Variable	Category	Frequency (n)	Percentage (%)
Age Group (years)	18–22	68	34.0%
	23–27	74	37.0%
	28–35	58	29.0%
Gender	Male	104	52.0%
	Female	96	48.0%
Educational Qualification	Undergraduate	102	51.0%
	Postgraduate	82	41.0%
	Others (Diploma, Professional courses)	16	8.0%
Primary AI Tool Used	Learning Applications	102	51.0%
	Visual AI Tools	53	26.5%
	Voice Assistants	28	14.0%
	Chatbots	17	8.5%
Purpose of AI Tool Usage	Academic	128	64.0%
	Skill Development	42	21.0%
	General Knowledge	30	15.0%

Statistical Analysis

Data collected from the structured interview schedule and the Metacognitive Skills Scale were processed and analyzed using Statistical Package for the Social Sciences (SPSS) software. Descriptive statistics, including mean and standard deviation, were calculated to summarize participants’ metacognitive skill scores across different groups. To examine whether there were statistically significant differences in metacognitive skill levels based on demographic variables such as gender and age categories,

independent sample t-tests and one-way Analysis of Variance (ANOVA) were employed. ANOVA was also used to assess group differences in metacognitive scores based on the type of AI tool most frequently used by participants (chatbots, voice assistants, learning apps, visual AI tools). Where ANOVA results showed statistical significance, post-hoc Tukey tests were conducted to identify specific group differences. A confidence level of 95% (p < 0.05) was used as the threshold for determining statistical significance throughout the analysis. This

combination of descriptive and inferential statistics provided a comprehensive understanding of the impact of various factors on metacognitive skill development among young adult users of AI tools.

Result

The analysis aimed to assess the influence of different AI tools on metacognitive skills and examine variations based on gender and age.

Table 2: Descriptive Statistics of Metacognitive Skills

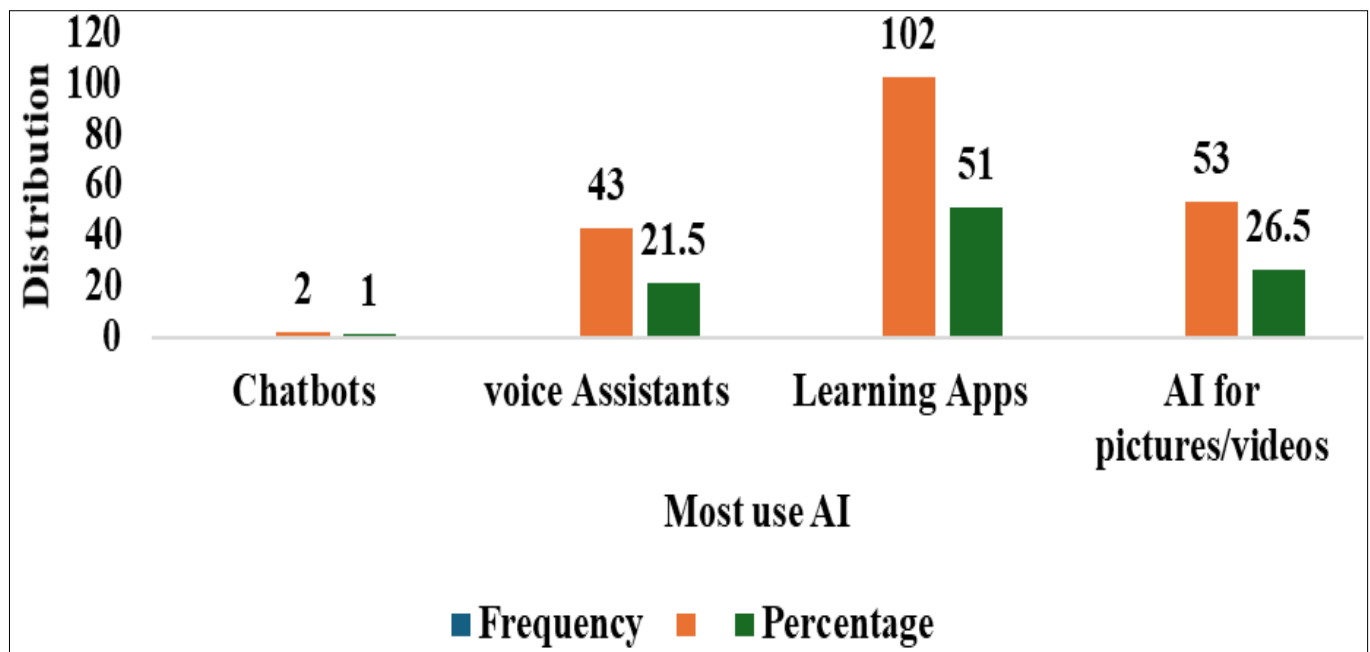
Metacognitive Dimension	Mean (M)	Standard Deviation (SD)	Interpretation
Planning	3.81	0.63	Highest among dimensions
Monitoring	3.76	0.59	Consistently high
Self-Regulation	3.68	0.62	Moderately high
Reflection	3.63	0.57	Lowest, but still moderately high
Overall Score	3.72	0.58	Moderately high metacognitive awareness

The overall mean score for metacognitive skills among participants was 3.72 (SD = 0.58) on a 5-point scale, indicating a moderately high level of metacognitive awareness. Among the four dimensions, planning (M =

3.81, SD = 0.63) scored highest, followed by monitoring (M = 3.76, SD = 0.59), self-regulation (M = 3.68, SD = 0.62), and reflection (M = 3.63, SD = 0.57).

Table 3: Types of AI Tools Used Most Frequently

Most Use AI	Frequency	Percentage
Chatbots (ChatGPT, Bard, etc.)	2	1.0
voice Assistants (Siri, Alexa, Google Assistant)	43	21.5
Learning Apps (Grammarly, Duolingo, etc.)	102	51.0
AI for pictures/videos	53	26.5
Total	200	100.0

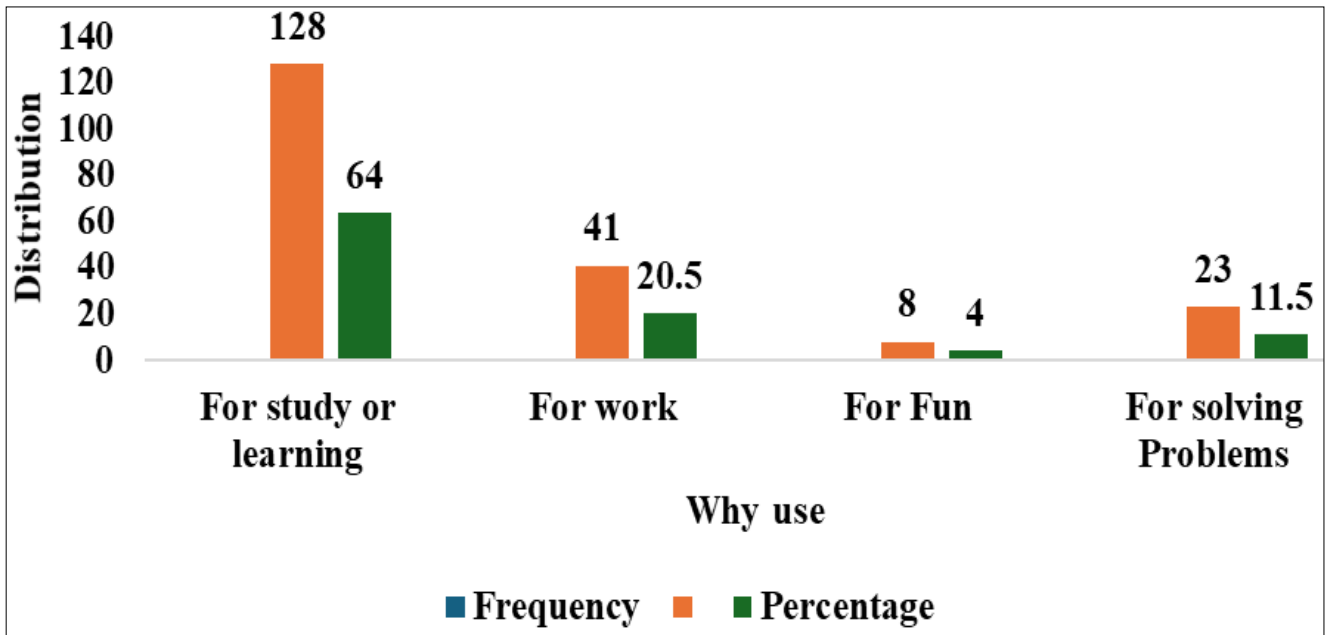


The data shows that AI-based learning apps (like Grammarly and Duolingo) are the most frequently used, with 51% of respondents relying on them to support academic and personal skill development. AI tools for images and videos are used by 26.5%, highlighting their role in creative tasks. Voice assistants (21.5%) are used for quick and convenient help with daily functions but are less tied to

metacognitive use. Surprisingly, only 1% use chatbots like ChatGPT, possibly due to limited awareness or preference for more specific tools. Overall, the results suggest that learning and creative AI tools play a more influential role in everyday activities and may help improve metacognitive skills by encouraging feedback and self-monitoring.

Table 4: Purpose of AI Tool Usage among Participants

Purpose of AI Tool Usage	Frequency (n)	Percentage (%)	Interpretation
For Study or Learning	128	64.0	Primary use; majority of participants
For Work	41	20.5	Secondary purpose, especially professionals
For Solving Problems	23	11.5	Used to assist with academic or daily tasks
For Fun	8	4.0	Least common purpose
Total	200	100.0	

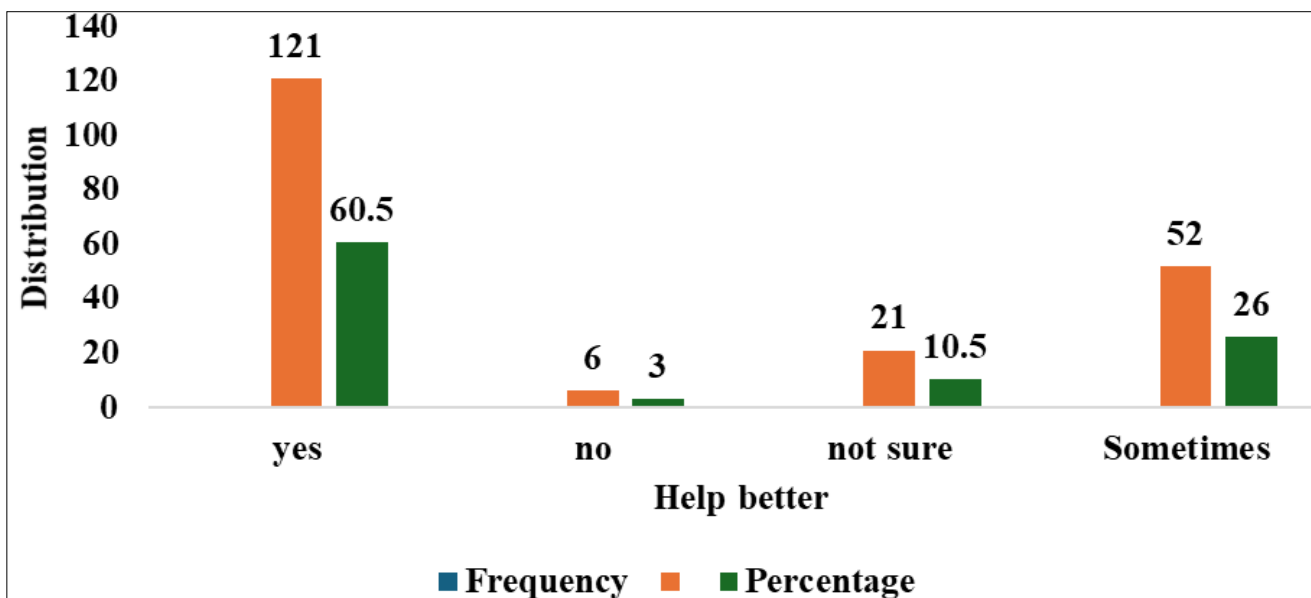


The data shows that 64% of respondents use AI tools mainly for academic purposes, highlighting their educational value. 20.5% use them for work-related tasks, while 11.5% use

them for problem-solving. Only 4% use AI tools for entertainment. This indicates that AI tools are primarily perceived as functional aids for learning and productivity, with potential to support metacognitive development.

Table 5: Perception of AI Tools in Enhancing Learning

Response Category	Frequency (n)	Percentage (%)	Interpretation
Yes	121	60.5	Majority perceive AI tools as beneficial for learning
Sometimes	52	26.0	Conditional or situational effectiveness acknowledged
Not Sure	21	10.5	Uncertainty about the impact of AI tools
No	6	3.0	Minimal skepticism or negative perception
Total	200	100.0	



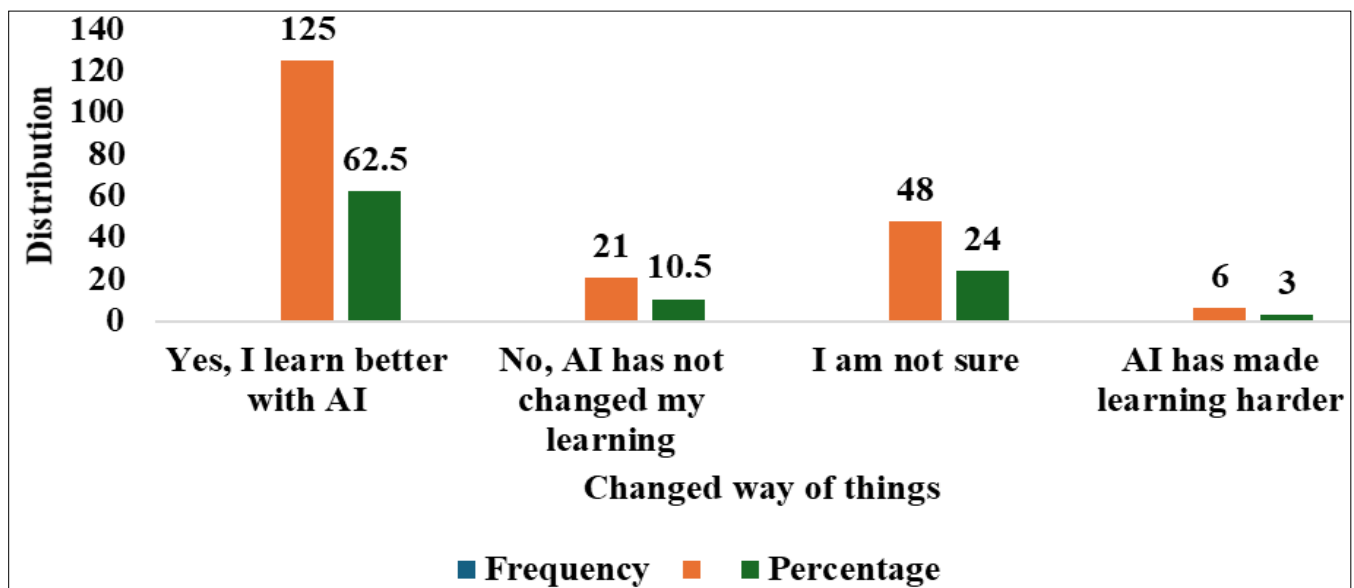
The findings show that 60.5% of respondents believe AI tools improve their performance, reflecting a generally positive perception of AI’s role in enhancing productivity

and learning. 26% feel AI helps them only in certain situations, while 10.5% are uncertain about its impact. A small portion, 3%, reported that AI does not aid them

performance. These results indicate overall optimism toward AI tools, though individual experiences and task contexts influence perceptions of their effectiveness.

Table 6: Distribution of perception of AI’s Role in Changing Learning Patterns

Perception Statement	Frequency (n)	Percentage (%)	Interpretation
Yes, I learn better with AI	125	62.5	Majority experienced positive transformation in learning
I am not sure	48	24.0	Considerable portion remains uncertain about AI’s impact
No, AI has not changed my learning	21	10.5	Minority reported no noticeable difference
AI has made learning harder	6	3.0	Very few found AI tools to be detrimental to learning
Total	200	100.0	



The data reveals that 62.5% of respondents feel they learn better with AI, highlighting its positive impact on engagement, understanding, and skill development. 24% are uncertain about its effect, while 10.5% report no change in

their learning styles. A small group (3%) felt that AI made learning more difficult. Overall, the findings suggest that AI tools support personalized and metacognitive learning, though individual experiences vary.

Table 5: Distribution of Respondents’ Metacognitive Scores by Type of AI Tool Used (One-way ANOVA, N = 200)

AI Tool Category	Mean Score	Standard Deviation (SD)
Chatbots (e.g., ChatGPT, Bard)	58.61	12.07
Voice Assistants (e.g., Siri, Alexa)	62.64	14.75
Learning Apps (e.g., Grammarly, Duolingo)	66.87	8.30
Visual AI Tools (e.g., AI for images/videos)	66.97	13.72
Total	62.11	13.49

ANOVA Results	
F-value	3.67
Significance (p-value)	0.013

A one-way ANOVA revealed a significant difference in metacognitive ability across different AI tool user groups ($F = 3.67, p = 0.013$). Users of Learning Apps ($M = 66.87$) and Visual AI Tools ($M = 66.97$) showed higher metacognitive scores compared to those using Voice Assistants ($M = 62.64$) and Chatbots ($M = 58.61$). This indicates that learning- and creation-focused AI tools may better support metacognitive skills like planning, self-monitoring, and reflection than passive tools.

Discussion

This study examined how different categories of Artificial Intelligence (AI) tools influence metacognitive skills specifically planning, monitoring, self-regulation, and reflection among young adults. The findings provide valuable insights into the relationship between digital tool usage and self-directed learning development. The results indicated a moderately high level of overall metacognitive awareness ($M = 3.72$) among the participants, with planning

emerging as the most developed skill dimension. This may reflect the fact that modern learners actively engage in goal-setting and time management, particularly when supported by structured AI-based platforms. One of the key findings was that learning apps and visual AI tools had a more significant positive effect on metacognitive skills than chatbots or voice assistants. This aligns with previous research suggesting that interactive and feedback-rich environments enhance metacognitive engagement. For example, platforms like Duolingo or Grammarly not only guide learning but also offer performance feedback and adaptive content, promoting deeper reflection and self-monitoring. In contrast, passive AI tools such as chatbots and voice assistants typically deliver quick answers without prompting the user to evaluate, revise, or reflect on their cognitive process. As a result, these tools may have limited capacity to foster deeper self-regulation and critical thinking. The statistically significant ANOVA results ($F = 3.67$, $p = 0.013$) reinforce the idea that not all AI tools contribute equally to learning development. The higher mean scores for learning app and visual AI users suggest that AI tools designed with educational scaffolding features are more effective in promoting metacognition. Additionally, the perception data showed that a large majority of participants felt that AI tools helped improve their learning (60.5%) and even changed their learning patterns (62.5%). This perception is crucial, as self-belief in learning improvement can itself enhance metacognitive engagement. These findings underscore the growing integration of AI into educational practices, but also highlight the need for digital literacy and critical tool selection. Learners and educators should be encouraged to engage with AI tools that promote reflection, goal setting, and self-assessment to truly enhance learning outcomes

Conclusion

This study provides empirical evidence on the influence of various AI tools on the metacognitive skills of young adults. The results highlight that learning apps and visual AI tools significantly enhance metacognitive abilities particularly in areas of planning, monitoring, self-regulation, and reflection compared to more passive tools like chatbots and voice assistants. Participants who engaged with interactive, feedback-driven AI platforms demonstrated higher levels of metacognitive awareness and reported improved learning outcomes. The findings suggest that not all AI tools are equally effective in fostering metacognitive development, and their impact largely depends on the nature of user interaction and tool functionality. This emphasizes the importance of critical digital literacy; users must be equipped not only to access AI tools but also to engage with them in ways that promote self-regulated learning. In conclusion, while AI presents substantial opportunities for enhancing cognitive and metacognitive engagement, its educational potential is maximized when tools are thoughtfully selected and integrated with learning goals. Future research should explore longitudinal effects, tool-specific pedagogies, and strategies for optimizing AI use in formal and informal learning environments.

References

1. Holmes W, Bialik M, Fadel C. Artificial Intelligence in Education: Promises and Implications for Teaching and Learning. Center for Curriculum Redesign, 2019.
2. Ifenthaler D, Yau JYK. Utilising learning analytics to support study success in higher education: A systematic review. *Educational Technology Research and Development*, 2020;68(4):1961–1990. <https://doi.org/10.1007/s11423-020-09788-z>
3. Luckin R, Holmes W, Griffiths M, Forcier LB. Intelligence unleashed: An argument for AI in education. Pearson Education, 2016.
4. Zawacki-Richter O, Marín VI, Bond M, Gouverneur F. Systematic review of research on artificial intelligence applications in higher education – where are the educators? *International Journal of Educational Technology in Higher Education*, 2019;16(1):39. <https://doi.org/10.1186/s41239-019-0171-0>
5. Roll I, Wylie R. Evolution and revolution in artificial intelligence in education. *International Journal of Artificial Intelligence in Education*, 2016;26:582–599. <https://doi.org/10.1007/s40593-016-0110-3>
6. Wong J, Baars M, Davis D, Van der Zee T, Houben GJ, Paas F. *et al* Supporting self-regulated learning in online learning environments and MOOCs: A systematic review. *International Journal of Human-Computer Interaction*, 2022;38(4):353–373. <https://doi.org/10.1080/10447318.2021.1936074>
7. Etikan I, Musa SA, Alkassim RS. Comparison of convenience sampling and purposive sampling. *American Journal of Theoretical and Applied Statistics*, 2016;5(1):1–4. <https://doi.org/10.11648/j.ajtas.20160501.11>
8. Creswell JW, Poth CN. Qualitative inquiry and research design: Choosing among five approaches (4th ed.). SAGE Publications, 2018.