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PAPER

Utilization of Generative Artificial Intelligence Technologies as Learning Tools among University Students: A Cross-Sectional Study

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ABSTRACT

Artificial intelligence (AI) technologies have the potential to revolutionize the higher-education landscape by offering personalized and adaptive learning experiences. This study aimed to investigate the utilization of AI technologies as a learning tool among university students and identify the factors influencing it. This study utilized a cross-sectional design and collected data through a self-administered questionnaire developed based on the technology acceptance model and Theory of Planned Behavior (TPB). Data from 581 respondents were analyzed using SPSS version 29, employing descriptive statistics and multivariate hierarchical multiple linear regression analysis. The study found that AI technologies were widely utilized by students for various academic tasks, with clarifying understanding (76.1%), paraphrasing (71.6%), and academic translations (71%) being the most common. ChatGPT (91.4%), QuillBot (82.8%), and Grammarly (79.7%) emerged as the most popular AI tools among the participants. A hierarchica1l multiple regression analysis revealed that motivation ($\beta = .17$, $p = .002$), subjective norms ($\beta = .14$, $p < .001$), and intention to use ($\beta = .49$, $p < .001$) were significant predictors of AI technology use among students. This study highlights the widespread adoption of AI technologies for academic tasks among university students. Higher education institutions foster an environment that enhances students' motivation, addresses subjective norms, and cultivates a positive intention towards AI technology adoption to facilitate its effective integration into the learning process.

KEYWORDS

Artificial intelligence (AI) technologies, learning tools, Sarawak

1 INTRODUCTION

Artificial intelligence (AI) technologies have rapidly evolved and permeated various sectors, including education. The integration of AI into higher education has garnered significant attention owing to its potential to revolutionize teaching,

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learning, and administrative processes [1]. AI-powered tools and applications offer a range of capabilities such as personalized learning experiences, intelligent tutoring systems, automated grading, and predictive analytics [2]. As a result, universities and colleges are increasingly exploring the adoption of AI technologies to enhance student engagement, improve learning outcomes, and streamline institutional operations.

However, the successful implementation of AI in higher education hinges on understanding students' perceptions, attitudes, and readiness to embrace these technologies [3]. Previous studies have highlighted the importance of perceived usefulness, ease of use, subjective norms, and behavioral intentions in shaping students' acceptance and adoption of educational technologies [4], [5]. Additionally, researchers have emphasized the need to investigate the ethical implications, potential biases, and privacy concerns associated with AI applications in educational settings [6], [7].

Despite the growing body of research on AI in higher education, there is a need for comprehensive studies that explore the patterns of AI technology utilization among university students, the specific tools they employ, and the factors influencing their adoption and integration into the learning processes. By understanding these dynamics, educational institutions can develop informed strategies to effectively leverage AI technologies, address potential challenges, and ensure a seamless transition towards AI-enhanced learning environments [2], [1].

This cross-sectional study aims to contribute to existing knowledge by investigating the utilization of AI technologies as learning tools among university students, examining the types of AI tools employed, and identifying the key factors that influence their adoption and integration into academic activities. The findings of this study can provide valuable insights for higher education institutions, policymakers, and educational technology developers to optimize the implementation and acceptance of AI technologies in the learning landscape.

2 METHODOLOGY

2.1 Population and sample

This study analyzed students' behavioral intentions regarding adopting AI in their learning processes. Thus, this cross-sectional study at the Universiti Malaysia Sarawak (UNIMAS) aims to explore the use of AI technologies as learning tools among university undergraduate students. The targeted population encompassed undergraduate students from all years and faculty at UNIMAS, without restrictions based on age, gender, or nationality. To find a good estimate of the usage of AI technology as a learning tool among students and the factors affecting it, we used the following formula for calculating the sample size with a 71% prevalence of the AI technology awareness index considered as the base prevalence [8].

The sample size was calculated using the following formula:

$$n = DE * \frac{z^2 * p(1-p) * N}{d^2(N-1) + z^2 * p(1-p)} + NR \quad (1)$$

With a design effect of 1.5, there was a non-response rate of 20% and a prevalence of 71% for AI technology awareness. The required sample size was 628, and 585 students from all faculties except computer science participated. Four responses were excluded due to incomplete information. This systematic sampling approach ensured representation from all years and faculties, providing insights into the factors influencing AI technology adoption for learning among undergraduate students.

2.2 Data collection instruments and data collection procedure

This study employed a self-administered survey questionnaire to collect data on university students' behavioral intentions regarding the adoption and use of AI technologies in their learning experiences. The questionnaire, designed based on the technology acceptance model [9] and Theory of Planned Behavior (TPB) framework, comprised eight sections: knowledge of AI technologies, attitudes and motivation towards integrating AI technology in learning, perceived usefulness, ease of use, subjective norms of AI technology use, perceived behavioral control (PBC), intention to use AI technologies, current use of AI technologies in learning and its purposes, patterns and purposes of AI technology usage, and demographic characteristics. The data collection process involved administering a validated, self-administered, structured, and bilingual (English and Bahasa Melayu) questionnaire to respondents after obtaining informed written consent and approval from the faculty administration. Respondents were given ample time to complete the questionnaire to ensure that no individually identifiable data were recorded.

2.3 Measurement

Knowledge about AI technologies in learning: A cognitive construct referring to the accumulation of factual information, skills, understanding, and awareness of AI technologies and their application in the educational sphere. In this study, it is quantified by the depth and breadth of a student's familiarity with the principles, functionalities, advantages, disadvantages, and potential uses of AI tools in a learning environment. We developed multiple-choice questions with three answer options, correct, incorrect, and not sure, to assess a wide array of AI-related topics, ensuring a comprehensive assessment of students' understanding and familiarity with AI in education.

Attitude towards AI technologies in learning: A psychological construct characterized by an individual's evaluative judgment about using AI technologies in their educational endeavors. It was measured on a likert scale ranging from strongly disagree to strongly agree. A higher score indicated a positive attitude.

Motivation: A psychological construct was measured using a Likert scale ranging from strongly disagree to strongly agree. It is quantified by the students' expressed reasons (both intrinsic and extrinsic) for using or wanting to use AI tools in their learning process.

Perceived usefulness: A cognitive construct measured on a Likert scale ranging from strongly disagree to strongly agree. This signifies a student's subjective assessment of the extent to which they believe using AI technologies in their educational activities will enhance their learning outcomes, efficiency, and overall academic performance.

Perceived ease of use: A cognitive construct measured on a Likert scale ranging from strongly disagree to strongly agree. It represents a student's subjective assessment of the simplicity, convenience, and effortlessness of using AI technology in their educational activities.

Subjective norms: A social construct measured on a Likert scale ranging from strongly disagree to strongly agree. It encompasses an individual's perceptions of influential figures' beliefs, expectations, and opinions regarding the use of AI technologies in education.

Perceived behavioral control: A psychological construct was measured on a Likert scale ranging from strongly disagree to strongly agree. It reflects an individual's

subjective assessment of their ability, resources, and external factors that influence their capacity to effectively use AI technologies for educational purposes.

Intention to use AI technologies: A cognitive construct measured on a likert scale from strongly disagree to strongly agree. This signifies an individual's conscious willingness, plan, and determination to incorporate AI technologies as tools for learning in a higher education setting.

Use of AI technologies: A behavioral construct representing a student's observable actions, interactions, and engagements with AI technologies in their learning activities within a higher education context.

2.4 Data analysis

A questionnaire pre-test was conducted to assess the responses' validity, comprehensiveness, and average duration [10]. Modest adjustments were made based on the pretest responses, followed by a reliability analysis using Cronbach's alpha, with a value of 0.7 or above considered reliable [11]. The researchers assessed the lconvergent and discriminant validity of the likert scale questions and domains to confirm the quality of the statistical model [12], [13]. The completed data from respondents were entered into Microsoft Excel with validation checks, assessed, verified, and transferred to SPSS version 29.0 [14] for further analysis. Descriptive analysis was presented in frequency tables or graphs, followed by bivariate analysis using Pearson's correlation test to examine the association between the use of AI technology and students' knowledge, attitudes, motivation, perceived usefulness, ease of use, subjective norms, intentions, and behavioral control. Multivariate analysis determined the strength of the correlation and factors associated with using AI technologies [12], [13], with a p-value of 0.05 considered statistically significant. The researchers followed the American Psychological Association style for citations [15].

2.5 Ethical issues

Written informed consent was obtained from all respondents after clearly outlining the study guidelines and parameters. The respondents acknowledged their voluntary participation and the confidentiality of their personal information and provided approval before participating. The Medical Ethics Committee of the Faculty of Medicine and health sciences at UNIMAS granted ethical approval (Ref # FME 24/08), ensuring that the research complied with the ethical standards and guidelines.

3 RESULTS

3.1 Characteristics of the students

There were 581 students who participated in this study. The majority of students (41.0%) were 21 years old, followed by 22 years (30.5%), 23 years or older (18.4%), and 20 years or younger (10.2%). In terms of year of study, half of the students (50.8%) were in their second year, 31.0% were first-year students, and 18.2% were in their third year. The gender distribution showed a higher proportion of female students (67.8%) than of male students (32.2%). Most students (69.2%) resided in university

colleges, 18.9% lived outside the campus, and 11.9% lived with their families (refer to Table 1).

Table 1. Characteristics of the students (N = 581)

Characteristics	N	%
Age in years		
≤20	59	10.2
21	238	41.0
22	177	30.5
≥23	107	18.4
Year of study		
Year 1	180	31.0
Year 2	295	50.8
Year 3	106	18.2
Gender		
Male	187	32.2
Female	394	67.8
Living status		
University college	402	69.2
Outside campus	110	18.9
With family	69	11.9

3.2 Uses patterns of AI technologies in higher education

The utilization of AI in higher education spans various aspects ("see Figure 1"). The highest reported use was for clarifying understanding, accounting for 76.1% of respondents, indicating a significant reliance on AI to clarify concepts and enhance comprehension. Paraphrasing tasks also demonstrated substantial AI usage (71.6%), highlighting its role in effectively aiding students in rephrasing content. In academic translations, AI was utilized by 71% of respondents, showcasing its value in facilitating language translation tasks. Reference materials search for significant AI integration, with 68.8% of respondents utilizing AI to access scholarly resources efficiently. Coursework assistance through AI was prevalent, with 68.3% of respondents leveraging AI tools to effectively manage and complete course-related tasks. Collaborative efforts benefit from AI, as seen in group work, where 67.9% of respondents utilized AI tools for collaboration and project management. The study sessions leverage AI at 67.5%, indicating its role in organizing and optimizing study schedules. AI aids significantly in assignment writing, with 64% of respondents using AI tools to draft and edit assignments efficiently. The literature review tasks witnessed AI usage at 62.8%, showcasing its utility in gathering and synthesizing research literature. Solving academic quizzes is another area where AI is utilized, with 59.5% of respondents using AI tools for practice quizzes and assessments. Notetaking tasks benefit from AI tools, with 56.1% of respondents leveraging AI for effective notetaking and organization.

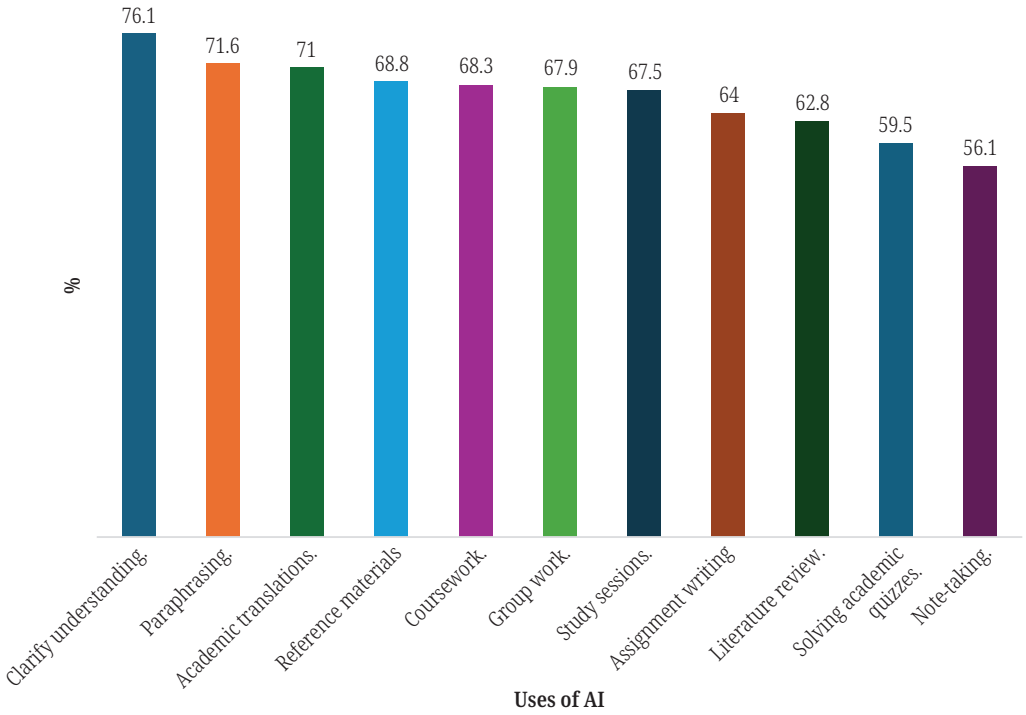

Fig 1. Uses of AI technologies in higher education

3.3 Types of AI technologies use

The most commonly used AI tool was ChatGPT, which was used by 91.4% (531) of the participants. QuillBot and Grammarly were also popular, being used by 82.8% (481) and 79.7% (463) of the participants, respectively. Other AI tools with high usage rates included CapCut (75.6%), TikTok (67.0%), Scribd (64.9%), and Google Bard (36.1%). Bing AI (32.0%), Watson AI (22.9%), Claude AI (15.8%), JotBot AI (10.7%), Jenni AI (9.1%), and Harpa AI (8.4%) were also among the AI technologies used by the participants. Additionally, 9.3% (54) of the participants reported using other AI tools, such as the Consensus and Research Rabbit (refer to Table 2).

Table 2. Types of AI technologies use (N = 581)

Types of AI Tools Used	N	%
ChatGPT	531	91.4
QuillBot	481	82.8
Grammarly	463	79.7
Capcut	439	75.6
Tiktok	389	67.0
Scribd	377	64.9
Google's Bard	210	36.1
Bing AI	186	32.0
Watson	133	22.9

(Continued)

Table 2. Types of AI technologies use (N = 581) *(Continued)*

Types of AI Tools Used	N	%
Claude Ai	92	15.8
JotBot	62	10.7
Jenni Ai	53	9.1
Harpa Ai	49	8.4
Others, such as Consensus, Research Rabbit, etc	54	9.3

Note: *Multiple responses.

3.4 Factors affecting uses of AI technologies in higher education: Hierarchical multiple linear regression

Table 3 presents the results of a hierarchical multiple linear regression analysis examining the factors affecting the use of AI technologies in higher education. The dependent variable was the use of AI technologies, and the predictors included demographic characteristics (age, year of study, gender, and living status), knowledge about AI technologies, attitude towards AI technologies, motivation, perceived usefulness, perceived ease of use, subjective norms, and intention to use AI technologies.

Comparing the two models, additional predictors compared to Model 2 increased predictive ability compared to Model 1. The results suggest that motivation, subjective norms, and intention to use AI technologies were significant predictors of the outcome variable in this model. Model 2 appears to be a better fit for the data, as it includes significant predictors that are not present in Model 1. The model fit measures indicate that Model 2 is better at predicting the use of AI technologies in higher education than Model 1. Model 2 had a higher R^2 value (0.553), suggesting that the predictors explain 55.3% of the variance in AI technology use. Additionally, it had a lower RMSE (5.86) and a highly significant F-statistic (54.01, $p < .001$), indicating a good model fit and that the predictors significantly improved the model compared to a model with no predictors. In contrast, Model 1 had a weak R^2 (0.0208), a high RMSE (8.67), and an insignificant F-statistic (2.04, $p = .059$), suggesting a poor model fit and that the predictors did not significantly improve the model's predictive ability.

The unstandardized beta coefficients represent the change in the dependent variable associated with a one-unit increase in the predictor variable, holding all other predictors constant. The standardized beta coefficients (β) indicate the relative importance of each predictor in the model. Analysis indicated that higher motivation ($\beta = .17$, $p = .002$) is associated with increased use of AI technologies, positive subjective norms ($\beta = .14$, $p < .001$) are associated with higher use of AI technologies, and a stronger intention to use AI technologies ($\beta = .49$, $p < .001$) is associated with increased actual use. Other predictors, such as age, year of study, gender, living status, knowledge, attitude, perceived usefulness, and perceived ease of use, were not significant predictors of AI technology use in this model. The 95% confidence intervals (CI) provided a range of plausible values for the standardized beta coefficients. For example, the 95% CI for the unstandardized beta coefficient of motivation was (0.06, 0.27), indicating that the true value of the coefficient is likely to fall within this range (refer to Table 3).

Table 3. Factors affecting the use of AI technologies in higher education: Hierarchical multiple linear regression analysis

Predictor	Unstd Beta	SE	β	95% CI	
				LL	UL
Intercept[a]	–15.79	7.09			
Age in years	0.18	0.30	.02	–0.05	0.09
Year 2–Year 1	0.74	0.61	.08	–0.05	0.22
Year 3–Year 1	0.75	0.95	.09	–0.13	0.30
Female–Male[a]	–1.00	0.54	–.11	–0.23	0.01
University college–family	–0.02	0.78	.00	–0.18	0.17
Outside campus–family	–0.88	0.94	–.10	–0.31	0.11
Knowledge	0.01	0.01	.03	–0.03	0.09
Attitude	0.05	0.04	.06	–0.04	0.16
Motivation	0.12	0.04	.17**	0.06	0.27
Perceived usefulness	0.00	0.04	.00	–0.08	0.08
Perceived ease of use	–0.04	0.04	–.04	–0.13	0.04
Subjective norms	0.13	0.04	.14***	0.07	0.22
Intention to use	0.31	0.03	.49***	0.40	0.58

Notes: [a]Represents reference level, LL = Lower limit of 95% confidence interval, UL = Upper limit of 95% confidence interval. *p < .05, **p < .01, ***p < .001.

4 DISCUSSION

This study investigated the utilization of AI technologies as learning tools among university students. The findings revealed the widespread adoption of AI technologies among students for various academic tasks, with clarification of understanding, paraphrasing, and academic translations being the most common uses. These findings align with previous research highlighting the potential of AI tools to enhance comprehension, content rephrasing, and language translation tasks in educational settings [2], [1]. Notably, ChatGPT, QuillBot, and Grammarly emerged as the most popular AI tools among participants, reflecting the growing popularity and acceptance of these technologies among students. This trend is consistent with the increasing adoption of AI-powered writing assistants and language processing tools in higher education [6], [7], [16].

The hierarchical multiple regression analysis revealed that motivation ($\beta = .17$, $p = .002$), subjective norms ($\beta = .14$, $p < .001$), and intention to use ($\beta = .49$, $p < .001$) were significant predictors of AI technology use among students. These findings align with the technology acceptance model [9] and TPB, emphasizing the importance of perceived usefulness, subjective norms, and behavioral intentions in shaping technology adoption [4]. Interestingly, factors such as perceived usefulness and ease of use were not significant predictors in this study, suggesting that students' motivation, social influences, and intentions played a more prominent role in driving AI technology adoption for learning purposes [17]. However, when users recognize the value and benefits of a new technology, they are more likely to embrace it and incorporate it into their daily lives [18].

This study's findings have important implications for higher education institutions and policymakers. To facilitate the effective integration of AI technologies in the learning landscape, fostering an environment that enhances students' motivation, addresses subjective norms, and cultivates a positive intention towards AI technology adoption is crucial [19]. This can be achieved through awareness campaigns, training programs, and the development of institutional policies and guidelines that promote the responsible and ethical use of AI in education [3], [20].

Furthermore, this study highlights the need for continuous research and evaluation of AI technologies in higher education to ensure their alignment with pedagogical goals, address potential biases and ethical concerns, and optimize their impact on student learning outcomes [6], [7].

This cross-sectional study has several limitations. It was not an experimental design; therefore, no causal relationships between variables could be established. A self-administered questionnaire may have introduced perceptional biases, as the responses were based on participants' subjective perceptions and self-reported data. Additionally, the study was conducted at a single university, raising concerns regarding the generalizability of the findings to other higher education institutions or contexts. Future research should consider longitudinal or experimental designs, objective measures, and more diverse samples from multiple universities to enhance the validity and generalizability of the results.

5 CONCLUSION

This study provides valuable insights into the patterns of AI technology usage among university students and the factors influencing their adoption. The findings revealed a high utilization of AI tools such as ChatGPT, QuillBot, and Grammarly for various academic tasks, including clarifying understanding, paraphrasing, translation, reference material search, coursework assistance, group work, assignment writing, literature review, and academic quizzes. Hierarchical multiple linear regression analysis identified motivation, subjective norms, and intention to use as significant predictors of AI technology adoption, while demographic factors, perceived usefulness, and ease of use were not significant predictors. Higher education institutions should foster a supportive environment that enhances students' motivation, addresses subjective norms, and cultivates a positive intention towards AI technology adoption. Additionally, further research should explore strategies to improve perceived usefulness and ease of use, as these factors may become more influential as AI technologies evolve and become more integrated into the educational landscape.

6 CONFLICT OF INTEREST

The authors disclose no conflicts of interest and affirm that the research was conducted with self-funding.

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8 AUTHORS CONTRIBUTION

Md Mizanur Rahman and Chai Chau Chung conceptualized the study, designed the study methods, analyzed the data, drafted the initial manuscript, critically reviewed and edited the manuscript, and approved the final version for publication. Angellisa Shanana, Sthanny Ajang Sim Chu Hua, Thiviyashree, and Elleyajasmin contributed to the conceptualization and design of the study methods, collected data, drafted sections of the manuscript, and approved the final version. All authors contributed substantially to the work and met the authorship criteria.

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