College Students' Use of Generative AI in Academic Tasks: Integrating Two-Stage Cluster Analysis

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***Abstract*—Generative artificial intelligence has ushered in a new phase of technological progress, and its effects are increasingly evident across various sectors, particularly in education. These advanced AI models, capable of generating human-like text, code, and even artwork, have the potential to transform both learning and teaching methods. As these technologies become more accessible and sophisticated, educators and students are evaluating the opportunities and challenges they present. This study aims to thoroughly investigate the usage profiles of college students by examining their characteristics and attributes, using a comprehensive two-stage cluster analysis as the primary methodological approach. Students from different colleges and universities participated in the survey. To effectively justify the clustering and profiling of students based on the identified attributes, the research employed the Technology Acceptance Model (TAM) in conjunction with the Theory of Planned Behavior (TPB). Through multiple iterations utilizing orthogonal fractional factor design, along with noise handling and the silhouette measure of cohesion and separation, students were categorized based on gender, type of institution, and preferred platforms. The analysis identified three primary clusters of students. The 'Enthusiasts' group consists of students who exhibit strong confidence and a high level of comfort using generative AI tools for their academic assignments and projects. The 'Practitioners' group comprises students who focus on applying their knowledge in real-world scenarios and benefit from a balanced learning approach. Meanwhile, the 'Cautious Experts' group includes students who critically evaluate AI usage and require further development in critical thinking and ethical considerations. The insights from this study can assist school administrators in creating a solid support framework and guidelines for educators and students who incorporate generative AI into their academic work. Awareness campaigns could promote responsible AI practices among students, including informative sessions on best practices and cautions against misuse. By implementing these strategies, the education system can foster a conducive learning environment that empowers students to use AI to enhance their education and prepare them for future careers.**

***Keywords*—generative Artificial Intelligence (AI), academic tasks, two-stage cluster analysis, attitude, student awareness, AI usage**

I. Introduction

The emergence of generative AI has fundamentally changed the field of education. Generative AI, often referred to as gen AI, is a type of artificial intelligence capable of producing original content such as text, images, videos, audio, or software code in response to a user's prompt. This technology relies on advanced machine learning models, intense learning models, which mimic the learning and decision-making processes of the human brain [1]. Generative AI has a variety of applications, including enhancing creative processes, automating content creation, improving customer service, and personalizing user experiences. However, it also brings challenges, such as potential biases in the generated content, ethical concerns, and the necessity for responsible usage [2].

The use of generative AI in education has significantly increased in recent years. Various studies and reports indicate that many educators and students are integrating generative AI tools into their academic routines. For example, a survey conducted by the Department for Education (DfE) in the UK found that by November 2023, 42% of primary and secondary teachers had used generative AI in their roles, a notable rise from 17% in April of the same year. Additionally, 74% of UK online users aged 16 to 24 reported using a generative AI tool [3].

Generative AI is being used in various educational applications. Educators utilize these tools to create quality resources, plan lessons, and streamline tasks like grading. Simultaneously, students rely on generative AI for homework help, content generation, and clarification of concepts. This widespread adoption reflects the technology's potential to enhance learning experiences, improve efficiency, and offer personalized pathways tailored to individual student needs. Incorporating generative AI into educational environments brings forth a range of challenges that need to be addressed. One significant concern is academic integrity; educators fear that students may misuse AI tools to complete assignments or exams, undermining the principles of honest academic work. Additionally, there are questions about the accuracy and reliability of content produced by AI systems. Misleading or incorrect information can create confusion, especially if students do not have the critical thinking skills to evaluate the content effectively. The ethical implications of AI usage in education cannot be overlooked. Issues such as data privacy, the potential for bias in AI algorithms, and the role of AI in shaping learning experiences are constantly being debated among educators and students alike. These concerns emphasize the need for clear guidelines and ethical standards in applying AI technologies [4].

Using generative AI in an academic institution has both benefits and challenges. One major issue is academic integrity; students might use AI to create work that is not theirs, leading to plagiarism and dishonesty. AI can also have biases based on the information it was trained on, which may reinforce stereotypes or unfair ideas in academic work. The information produced by AI might not always be accurate, so students need to check and verify the results carefully. Over-reliance on AI tools, reduced cognitive effort, a shift in the focus of critical thinking, and challenges in self-regulation can lead to diminished independent analytical abilities. To

tackle these problems, it is important to promote responsible use of AI, educate students about its limitations and biases, and establish strong rules about academic integrity.

There is growing awareness among school stakeholders about the challenges posed by generative AI technologies, yet significant gaps remain in understanding student profiles that engage with these tools. Limited research has explored how various demographics, such as age, socioeconomic status, and academic performance, use generative AI platforms and their attitudes toward these technologies [5]. Understanding how students from diverse backgrounds interact with generative AI is essential for educators and policymakers. This knowledge can help develop effective strategies that enhance learning while addressing ethical concerns. Insights into whether students view generative AI as a helpful resource or a shortcut that undermines academic integrity could guide responsible usage guidelines. By focusing on these areas, we can better grasp the potential benefits and risks of generative AI in education, ensuring its effective integration while protecting academic integrity. Addressing these gaps will help optimize AI's role as a valuable ally in achieving learning objectives.

The study sought to delve into the diverse and complex ways in which generative AI is utilized by college students. It aimed to examine their overall attitudes towards these technologies and their level of awareness regarding the various generative AI platforms available to them. Additionally, the research focused on identifying specific usage patterns among students, paying close attention to how frequently and in what contexts they engage with these platforms. By gaining insight into these dimensions' attitudinal factors, awareness levels, and usage behaviors, the study aims to provide a comprehensive understanding of student interactions with generative AI. This understanding is essential, as it can help in categorizing and profiling students based on their engagement with these advanced technologies, which could have implications for educational strategies, resource allocation, and future research in this rapidly evolving field.

II. Literature Review

A. Attitudes toward Generative AI

Understanding students' attitudes toward using AI in academic tasks is crucial for several reasons. Positive attitudes can lead to higher adoption rates and greater engagement with AI tools. When students feel confident and comfortable using AI, they are more likely to explore its full potential, significantly enhancing their learning experiences and productivity. This engagement fosters a dynamic and interactive learning environment, where students leverage AI to facilitate research, generate creative ideas, and streamline their workflows [6]. Additionally, recognizing and addressing the concerns of students who are skeptical or cautious about AI allows educators to provide tailored support and resources. This may include additional training and guidance to help these students use AI tools effectively and responsibly, ensuring that all students can benefit from the technology.

Insights into students' attitudes can inform curriculum development and promote the ethical use of AI. By understanding how students perceive AI, educators can design curricula that address both the benefits and limitations of the technology. This preparation is essential as AI becomes increasingly prevalent in various fields, helping students develop the skills needed for future careers. The awareness of students' attitudes can help educators tackle concerns about academic integrity and the potential for misinformation, guiding students toward responsible and critical use of AI tools [7, 8]. Understanding these attitudes can also drive innovation and improvement in AI applications, as feedback from students can lead to the development of more user-friendly and effective educational technologies that better meet their needs. Students' attitudes toward AI play a key role in how effectively these technologies are integrated into education, influencing both immediate learning outcomes and long-term educational strategies [9].

B. Awareness of Generative AI Limitations

Another vital attribute for students is their awareness of the limitations of generative AI. This understanding is essential for cultivating a responsible and critical approach to using these technologies in education. When students recognize that AI-generated content can sometimes be inaccurate, biased, or lacking in context, they are more inclined to evaluate such content critically. This perspective encourages them to verify information, cross-check sources, and treat AI as a supplementary tool rather than a primary source of knowledge [10].

By fostering critical thinking and discernment, students can maintain academic integrity and ensure the accuracy and credibility of their work. The responsible use of AI also aids in preventing the spread of misinformation and supports the development of strong analytical skills, which are crucial for academic success and lifelong learning. Furthermore, students' understanding of AI limitations can promote more effective and ethical integration of these technologies within the education system [11]. Educators can capitalize on this awareness by designing curricula that emphasize the strengths and weaknesses of AI, preparing students to utilize these tools effectively in their academic and professional pursuits. This knowledge can also inform the creation of guidelines and best practices for AI use in education, ensuring that students are equipped to navigate the ethical and practical challenges associated with AI. By nurturing a balanced and informed approach to AI, the education system can leverage the advantages of these technologies while mitigating potential risks, ultimately enhancing the quality and integrity of education [12, 13].

C. Students' Usage of Generative AI

The utilization of generative AI by students has the potential to significantly enhance the learning and education system by offering personalized and efficient learning experiences. These AI tools can assist students with a range of academic tasks, including writing, research, and problem-solving, by providing tailored suggestions and generating content that aligns with their specific needs. Such personalized assistance can help students grasp complex concepts more readily, refine their writing skills, and streamline their study processes [14]. A significant case study took place at Gongju National University in South Korea,

where generative AI was used in general English classes to improve how lessons were delivered. The results showed that using AI in instruction greatly boosted students' motivation, interest, and confidence in learning English when compared to traditional teaching methods [15]. Moreover, AI can deliver instant feedback and support, enabling students to learn at their own pace and address individual learning gaps. This level of customization and immediacy can result in more effective and engaging learning experiences, ultimately boosting academic performance and fostering a deeper understanding of the subject matter.

Conversely, the skill level of students plays a pivotal role in how they engage with generative AI tools. Those with a higher proficiency in technology are likely to maximize the benefits of AI, taking full advantage of advanced features and seamlessly integrating these tools into their academic work. These students can leverage AI to enhance their research, produce sophisticated content, and critically assess AI-generated information. In contrast, students with lower skill levels may require additional support and training to effectively utilize AI tools [16]. By providing resources and guidance to these students, educators can help bridge the gap, ensuring that all learners, regardless of their initial proficiency, can reap the advantages of generative AI. Addressing varying skill levels will enable educators to create a more inclusive and equitable learning environment where every student can succeed.

D. Teachers' View of AI Tools

Teachers generally perceive AI as a powerful tool that has the potential to significantly enhance both student learning and the assessment of their academic work [17]. The introduction of AI in educational settings presents several important benefits. For instance, AI can deliver personalized feedback tailored to the individual needs of students, allowing them to understand their strengths and weaknesses more clearly. Additionally, AI can streamline and accelerate the grading process, reducing the time that teachers spend on administrative tasks and enabling them to focus more on instruction and interaction with their students.

Moreover, AI can create more engaging and interactive learning experiences through adaptive learning technologies that adjust content based on student performance, fostering a more customized educational environment. AI-based assessments are also seen as a valuable alternative to traditional grading methods, which can often be time-consuming and subjective. With AI, the grading process can become more consistent and objective, potentially improving the reliability of student evaluations.

Despite these advantages, teachers harbor concerns regarding the potential biases inherent in AI systems. These biases can stem from the data used to train AI algorithms, leading to unfair or inaccurate outcomes in assessments. Therefore, educators stress the importance of meticulously reviewing AI-generated results to ensure they maintain fairness and accuracy across diverse student populations [18].

While AI is widely regarded as a beneficial resource in modern education, it is crucial to consider the ethical implications of its use. Continuous monitoring and evaluation of AI applications in classrooms are necessary to safeguard against negative consequences and to ensure that AI contributes positively to the educational experience, ultimately fostering an inclusive and equitable learning environment for all students.

E. Clustering and Profiling of Students

Clustering and profiling students based on their attitudes, awareness, and levels of engagement with generative AI are crucial for tailoring educational strategies to cater to diverse student needs. By gaining insights into these dimensions, educators can identify distinct groups of students who interact with AI in varying ways. For instance, some students may be enthusiastic and confident users, while others might approach it with caution or skepticism. Recognizing these differences enables educators to offer targeted support and resources, ensuring that each group receives the appropriate guidance and training. This personalized approach can significantly enhance the effectiveness of AI integration in education, helping students fully capitalize on the benefits of these technologies while addressing their unique concerns and challenges [19].

Likewise, clustering and profiling can guide the development of curricula and educational policies that promote the responsible and ethical use of AI. By understanding how different groups of students perceive and utilize AI, educators can design programs that emphasize critical thinking, digital literacy, and ethical considerations. This preparation can help students become more discerning users of AI, equipped to navigate its complexities and limitations [20]. The insights gained from profiling can inform resource allocation, such as investing in training programs for students with less experience or developing advanced AI tools for more proficient users. Ultimately, this approach fosters a more inclusive and equitable learning environment, allowing all students to benefit from advancements in AI technology.

III. Methodology

A. Research Design and Conceptual Framework

This study aimed to thoroughly investigate the usage profiles of college students by examining their individual characteristics and attributes, employing a comprehensive two-stage cluster analysis as its primary methodological approach [21, 22]. The research explicitly incorporates three distinct attributes within an orthogonal fractional factor design to systematically assess the wide range of stimuli presented in the survey, which is crucial for understanding the complex interactions between students and technology.

The conceptual framework depicted in Fig. 1 is meticulously constructed to encompass these attributes along with their corresponding levels, all of which are derived from students' essential demographic traits and their responses to the survey items. This framework is the foundation for the analysis and helps illustrate the relationships between the various factors influencing students' technology usage.

In the study's initial stage, the author systematically identified the relevant attributes and their respective levels. This process involved creating a structured group design and developing a survey questionnaire. The questionnaire incorporated materials and insights from existing literature to ensure its relevance and validity. To robustly justify the clustering and profiling of students based on the identified attributes, the research utilized the Technology Acceptance

Model (TAM) in conjunction with the Theory of Planned Behavior (TPB) [23]. The TAM is particularly useful in studying the profiling of college students using generative AI for academic purposes because it helps to understand the factors influencing their acceptance and use of this technology. It posits that technology's perceived usefulness and perceived ease of use significantly determine users' behavioral intentions and actual usage. By applying TAM, researchers can identify how students perceive the benefits and challenges of generative AI, such as its impact on their academic performance, ease of integration into their study routines, and any potential barriers to its adoption. This understanding can inform the development of targeted strategies to enhance the practical and ethical use of generative AI in educational settings, ensuring that students are well-prepared to leverage these tools responsibly and effectively. On the other hand, the TPB provides a broader perspective by considering the effects of social norms and perceived behavioral control on students' attitudes and subsequent usage behaviors.

The Unified Theory of Acceptance and Use of Technology (UTAUT), which includes broader concepts such as performance expectancy, effort expectancy, social influence, and facilitating conditions, was also included in the investigation. However, it is often more applicable to organizational settings and may not effectively address the nuanced individual-level factors that the Technology Acceptance Model (TAM) and the Theory of Planned Behavior (TPB) are better equipped to capture. This research aimed to provide a deeper understanding of how students engaged with AI technologies by combining two influential models. It explored students' attitudes, awareness levels, and unique usage patterns. Gaining this understanding was essential for creating customized educational strategies that improved learning outcomes and addressed the diverse needs of students.

Following identifying and framing the relevant attributes, a clustering design was meticulously generated using Statistical Packages for Social Sciences (SPSS) version 27. This involved grouping the observations into identifiable clusters while applying Schwarz's Bayesian Criterion (BIC) as a robust measure, utilizing log-likelihood as the distance measure to ensure accuracy in clustering. Finally, several statistical measures were employed to rigorously evaluate the acceptability and robustness of the clusters formed, including the Silhouette Measure, methods for Noise Handling, and evaluations of Predictor Importance. This multi-faceted approach ensures that the clusters are valid and helpful in understanding student behavior and informing future educational practices.

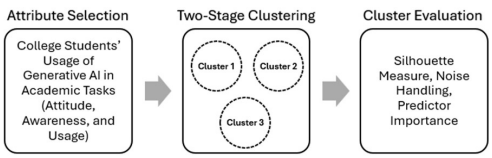

Fig. 1. Conceptual framework.

B. Respondents of the Study

In this study, stratified sampling was used to ensure a representative sample of 379 student participants from 18 institutions across the National Capital Region and Southern Luzon in the Philippines. By dividing the population into strata based on socioeconomic background, type of institution, and geographic location, the sample accurately reflected the diverse student population. The sample size for each institution was proportional to the population. This approach enhanced the precision and representativeness of the two-stage clustering analysis, allowing for effective noise handling and robust clustering results. Despite its complexity, stratified sampling provided a balanced and comprehensive understanding of the student population.

Differences in access to AI and digital skills can greatly affect how students use generative AI for their studies. In areas where technology and digital skills are limited, students may have difficulty using AI tools effectively. This can result in lower academic performance and fewer opportunities than students in more advanced regions. These gaps can make existing inequalities worse, as students in underserved areas often lack the skills and resources needed to make the most of AI for their learning. To tackle these issues, we need to take specific actions, like improving internet access, offering better digital skills training, and ensuring that all students have access to AI tools. These steps are crucial for creating a fair and supportive learning environment [24].

The respondents were enrolled in different academic programs, including but not limited to business, health, engineering, health sciences, multimedia, and social sciences. This diversity in fields of study contributed to a richer data set, reflecting the varied interests and educational paths of college students.

Purposive sampling was employed to gather this data. As defined by Sharma [25], purposive sampling involves the deliberate selection of participants based on specific characteristics or criteria that are relevant to the research. This method was chosen to ensure that the sample would appropriately reflect the broader student population, thereby facilitating the generalization of the findings.

The study aimed to recruit as many respondents as possible from different geographic and socioeconomic backgrounds, thereby enhancing the representativeness of the sample. By incorporating such a wide range of perspectives and experiences, the research sought to provide valuable insights into the academic challenges and opportunities faced by college students in the targeted regions.

C. Two-Stage Cluster Analysis

Two-stage cluster analysis is a statistical technique designed to identify and analyze clusters within a dataset by integrating two distinct clustering methods. This method offers several advantages over qualitative and traditional grouping methods. It enhances accuracy by reducing bias and ensuring that samples are more representative. This approach is particularly efficient for analyzing large populations and effectively managing complex data sets. It provides a robust statistical framework that enables the calculation of intra-cluster correlation, allowing researchers to identify similarities within clusters and differences between them. Its flexibility makes it applicable across various fields, including public health, market research, and social sciences, making it a valuable tool for diverse studies. In the first stage, a pre-clustering algorithm partitions the data into smaller sub-

clusters, which facilitates the management of large datasets. During the second stage, these sub-clusters are further combined into final clusters using hierarchical clustering techniques, refining the initial groupings to ensure they are both meaningful and distinct. As part of the analysis, noise handling was used to identify and manage data points that do not fit well into any cluster, commonly referred to as "noise" or "outliers". This process enhances the accuracy and robustness of the clustering results by preventing these noisy data points from distorting the true structure of the clusters. Two-stage clustering is particularly advantageous for datasets that include continuous and categorical variables, as it can automatically determine the optimal number of clusters, thereby enhancing the accuracy and efficiency of the analysis [26].

In this study, demographic characteristics such as sex, type of higher education institution, and preferred generative AI platform were added as part of the evaluation fields. However, the demographic data from the respondents exhibited an unbalanced proportion, making it challenging to segment students based on their profiles. Consequently, the cluster analysis restricted the number of clusters formed to a maximum of four and utilized evaluation fields to determine the optimal segments that could be created. Furthermore, the researcher assigned unique cluster names to the segmented results based on their responses in the survey.

IV. Result and Discussion

This study systematically gathered data from 379 individuals over a comprehensive period of 30 days (refer to Table 1 for details). In analyzing the demographic distribution of the respondents, it was found that a notable majority, 63.9%, were female, while 36.1% were male. The study examined the type of Higher Education Institution (HEI) that participants were affiliated with. The findings revealed that 57.5% of the respondents attended private schools, unlike 42.5% enrolled in public institutions. The study also investigated the preferred digital platforms utilized by respondents to complete their academic tasks. The results indicated a strong inclination towards ChatGPT, with 79.9% of participants reporting it as their primary choice. Other platforms included Gemini, formerly known as Bard, which was used by 10.6% of respondents, while Copilot accounted for 4.2%. Additionally, 5.3% of the participants indicated that they utilized various other platforms for their academic endeavors.

Table 1. Profile of the respondents (N = 379 respondents)

Characteristics	Classification	Count	Percent (%)
Sex	Female	242	63.9
	Male	137	36.1
HEI	Private	218	57.5
	Public	161	42.5
Preferred Platform	ChatGPT	303	79.9
	Gemini	40	10.6
	Copilot	16	4.2
	Others	20	5.3

A. Research Student Classification Based on Attributes

This research utilized a two-stage cluster analysis method to gain insights into students' usage profiles by systematically grouping individuals with similar characteristics based on specific attributes collected in the study. The findings, detailed in Table 2, illustrate the distribution of student classifications across three analyzed key attributes. The first attribute assessed was student awareness, categorized into three levels: high, moderate, and low. The data reveals that a significant portion of students, precisely 56.7%, exhibit a high level of awareness regarding the capabilities and limitations of generative AI technologies. This indicates that many students are not only familiar with these tools but also understand their potential implications. Following this group, 37.7% of students fall into the moderate awareness category, suggesting that while they possess some knowledge about generative AI, it may not be comprehensive. On the other hand, a small minority, comprising 5.5% of the respondents, is classified as having low awareness, indicating a lack of familiarity with generative AI concepts and tools. These findings highlight the varying degrees of awareness among students, which could inform future educational strategies to enhance understanding of generative AI in academic settings.

Table 2. Distribution of student profile based on attributes

Attributes	Classification	Count	Percent (%)
Student Awareness	High	215	56.7
	Moderate	143	37.7
	Low	21	5.5
Use of Generative AI Platforms	Advanced	167	44.1
	Intermediate	164	43.3
	Beginner	48	12.7
Attitude on Using Generative AI	High	150	39.6
	Moderate	171	45.1
	Low	58	15.3

The second attribute focuses on how students engage with various generative AI platforms while completing academic tasks. The data reveals that many students, representing 44.1% of the responses, possess advanced skills in utilizing these generative AI tools. This indicates a strong familiarity and competency when it comes to incorporating AI into their academic work, allowing them to leverage its capabilities effectively. Following closely is the category of intermediate users, which comprises 43.3% of the respondents. These students demonstrate a solid understanding of generative AI platforms, although they may not be as proficient as their advanced counterparts. This group likely utilizes generative AI for various academic purposes but may still be exploring the full range of features available. In contrast, only 12.7% of students use generative AI platforms as beginners. This smaller group may have limited experience or knowledge of these tools, which suggests that there is potential for growth and development in their skills. This means that the distribution of skill levels among students highlights the diverse range of experiences and expertise in employing generative AI for academic success.

The final attribute examined is the students' attitudes toward using generative AI to complete their academic tasks. A significant portion of the students, specifically 45.1%, exhibit a moderate level of interest and confidence in utilizing generative AI tools to assist them with their studies. This suggests that while these students are open to the idea of integrating such technology into their academic work, they may still have some reservations or a lack of familiarity with the tools. In contrast, a notable 39.6% of respondents report having a high level of interest and confidence in employing various generative AI platforms for their academic assignments. This indicates a strong willingness and belief in

the effectiveness of these tools to enhance their learning experience and assist them in achieving their academic goals. On the other end of the spectrum, a smaller group, comprising only 15.3% of the respondents, expresses low interest and confidence in the use of generative AI. This group may be hesitant to adopt these technologies, possibly due to concerns about their reliability, ethical implications, or a preference for traditional study methods. Overall, the data reflects a diverse range of attitudes towards generative AI among students, highlighting both enthusiasm and caution in its integration into academic life.

B. Cluster Analysis Results

The research involved a thorough classification of participants, focusing on three key dimensions: their levels of awareness regarding generative AI, their usage patterns, and their attitudes toward these tools. The primary objective of this classification was to uncover the specific characteristics that significantly affect college students' choices to employ generative AI tools in the completion of their academic assignments and tasks. By delving deeply into these factors, the study aspires to offer enhanced insights into the relationships between students' familiarity with technology, the frequency with which they use AI solutions, and their overall sentiments towards generative AI. Such an exploration seeks to illuminate how these factors interact and influence students' engagement and dependency on innovative educational tools in their academic pursuits. Throughout the research, multiple iterations were conducted using a two-stage clustering methodology. As a result, the clustering achieved a silhouette measure of cohesion and separation of 0.8. This score indicates that the separation of clusters, as outlined in Table 3, is robust and meets acceptable standards. To further refine the clustering process, a 10% noise handling approach was implemented to effectively identify and eliminate any outliers that could distort the results. Regarding the variables assessed, the 'Attitude' variable emerged as the most significant predictor, receiving a value of 1.0. This was closely followed by the 'Student Awareness' variable, which scored 0.93, and the 'Use' variable, which garnered a score of 0.35. These findings suggest that the formation of the three distinct clusters among students was predominantly influenced by their attitudes toward using generative AI tools when engaging in academic tasks. Overall, the results underscore the importance of students' perceptions and familiarity with AI technologies in shaping their academic choices and behaviors.

In a two-stage clustering process, "Evaluation Fields" are pivotal for thoroughly assessing the quality and validity of the resulting clusters. These fields assist in validating clusters through various metrics, such as silhouette scores, which measure how similar an object is to its own cluster compared to other clusters. They also support the selection of the most effective model by allowing for the comparison of different clustering solutions. Additionally, evaluation fields enhance the interpretability of the results by providing descriptive statistics, which summarize the characteristics of each cluster. They facilitate ongoing performance monitoring by tracking how the clusters evolve over time. All of these elements contribute to ensuring that the clustering results are not only robust but also meaningful and actionable for stakeholders.

Table 3. Distribution of student profile based on attributes

Cluster		Enthusiasts		Practitioners		Cautious Experts	
Distribution Based on Total		43.30%		31.10%		25.60%	
Silhouette Measure of Cohesion and Separation = 0.8, with 10% noise handling							
	PI[1]		PBT[2] (%)		PBT[2] (%)		PBT[2] (%)
Attributes	1	High Attitude	100	Moderate Attitude	83.5	Moderate Attitude	100
	0.93	High Awareness	85.8	Moderate Awareness	100	High Awareness	100
	0.35	Advanced User	78.7	Intermediate User	84.6	Advanced User	54.7
Evaluation Fields	0.04	Female	56.7	Female	69.2	Female	76
	0.03	Private	56.7	Private	54.9	Private	73.3
	0.01	ChatGPT	83.5	ChatGPT	79.1	ChatGPT	76

[1]Predictor Importance (PI), [2]Percent Based on Total per Cluster (PBT)

In this particular study, the selected evaluation fields included participants' sex, the type of Higher Education Institution (HEI) they attend, and their preferred digital platform for learning. The analysis revealed that the majority of the clusters were primarily composed of female students enrolled in private institutions, with a notable preference for ChatGPT as their learning platform compared to other available options. Despite these findings, it is essential to highlight that the predictor importance values were relatively low, ranging from 0.1 to 0.4. This suggests that the chosen evaluation fields might not significantly contribute to the clustering process and its outcomes. One possible explanation for this observation could be the significant imbalance in the proportions of the evaluation fields; for example, there is a notably larger number of female participants in the study compared to their male counterparts. This uneven distribution may dilute the influence of these fields on the clustering results and complicate the analysis further. That is why future studies may need to consider more balanced sampling or explore additional evaluation fields to improve the clustering process and its interpretability. Additionally, the category of higher education institutions did not demonstrate significant predictive importance in the analysis. As a result, this variable was omitted from the report presented in Table 3, which focuses on factors that have a more meaningful impact on the outcomes studied

1) Custer 1: The enthusiasts

This cluster comprises 43.3% of the students identified after systematically addressing and filtering out any noise in the data. The individuals in this group exhibit a high level of confidence in their ability to effectively use generative AI tools for academic purposes. They demonstrate a consistent sense of comfort when engaging with this technology and an enthusiastic attitude toward its capacity to enhance their learning experiences. Remarkably, 85.8% of these students possess a solid understanding of the limitations associated

with AI tools, particularly in relation to the accuracy of the information generated. This critical awareness equips them to approach AI-generated content with discernment, allowing them to evaluate the reliability of the information they encounter. Additionally, members of this cluster demonstrate advanced skills in differentiating between credible and misleading information produced by various generative AI platforms. Their adeptness in navigating the complexities of this technology suggests that they are not only proficient users but also critical thinkers, capable of assessing the validity and relevance of the information provided by AI tools. This combination of confidence, critical awareness, and skill makes them well-prepared to integrate generative AI into their academic pursuits while maintaining a thoughtful approach to its use [27].

2) Cluster 2: The practitioners

This group represents the second highest percentage of respondents, accounting for 31.1%, with only the category related to noise handling receiving more responses. Among these respondents, an impressive 83.5% express confidence in the potential of generative AI to significantly enhance their academic pursuits. They acknowledge a variety of advantages that this technology can provide, including increased efficiency in research activities, improvements in writing quality, and the ability to offer tailored learning experiences that cater to individual needs and learning styles.

However, despite their enthusiasm for the benefits of generative AI, members also convey important concerns regarding the potential adverse effects of incorporating this technology into educational environments. Key worries include challenges related to maintaining academic integrity, the danger of disseminating misinformation, and the potential erosion of critical thinking skills that may arise from over-reliance on automated tools.

All members of this group actively engage with AI tools while being mindful of their limitations and inherent biases. Such awareness is vital, as it allows users to critically assess the information generated by these technologies and to recognize the contexts in which they operate. Furthermore, members have shown a commendable level of understanding regarding the procedures for reporting inaccuracies in AI-generated content to the developers of these systems. This awareness emphasizes their commitment to using technology responsibly and ethically. A noteworthy finding is that 84.6% of members report a degree of confidence in their ability to discern between accurate and inaccurate information produced by generative AI platforms. This level of confidence suggests that they possess a solid foundational understanding of how these tools function and are proactive in verifying the information they encounter [28]. This proactive approach not only strengthens their critical thinking skills but also reinforces their commitment to maintaining academic integrity in their work. Through their engagement with generative AI, these members are navigating the complexities of modern educational technology while prioritizing ethical considerations and effective learning strategies [29].

3) Cluster 3: Cautious experts

This group constitutes 25.6% of the respondents after we have filtered out extraneous data that does not contribute to the overall findings. Although their perspectives align closely with those of the 'Enthusiasts' cluster, they possess unique views regarding the potential negative repercussions of generative AI in educational environments.

Members of this group firmly believe that, while generative AI can be a powerful tool, it is not without its limitations. They are aware of the various biases inherent in AI-generated content, as well as the constraints that these technologies impose. This awareness highlights their critical understanding of the shortcomings and flaws that accompany the use of generative AI.

Moreover, a significant proportion of this group, 54.7%, demonstrates a remarkable ability to identify errors produced by AI tools when used for academic purposes. This skill is crucial, as it indicates that they approach AI-generated information with a discerning eye, ensuring that they can maintain the integrity of their academic work. By recognizing and addressing inaccuracies, they contribute to a more accurate and reliable use of AI in educational settings, safeguarding the quality of information that students and educators rely upon.

V. Conclusion and Recommendation

This study showed three distinct profiles of students who use generative AI platforms for their academic tasks. Fig. 2 provides a detailed visualization of the clustering results derived from the analysis of three key attributes in the study. Each sector within the circle represents a different cluster, and the area of each sector is proportional to the size of that cluster among the total respondents. This distribution results from multiple iterations of data processing and noise cancellation techniques. The adjectives located within the open space of the largest circle serve as concise descriptors of the characteristics and attitudes of the members within each cluster.

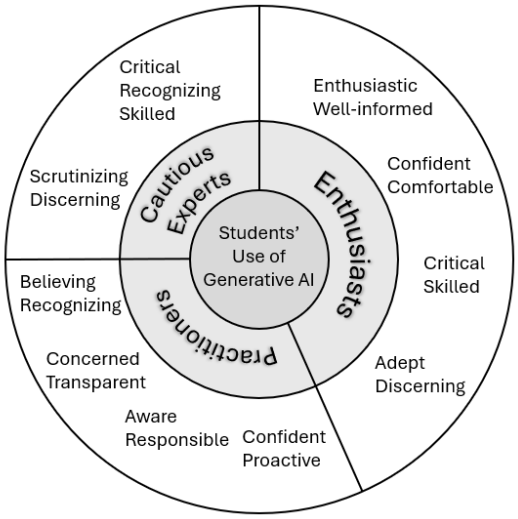

Fig. 2. Types of student users of generative AI.

The 'Enthusiasts' cluster comprises students with a strong sense of confidence and a high degree of comfort in utilizing generative AI tools for their academic assignments and projects. These individuals recognize the significant advantages of generative AI, including its ability to facilitate research, generate creative ideas, and streamline workflows, ultimately enhancing their learning experiences and overall

productivity. Moreover, Enthusiasts actively seek out ways to integrate these technologies into their study routines, often experimenting with various AI applications to maximize their effectiveness. Despite their optimistic outlook, they possess a realistic and balanced awareness of the limitations of these technologies. They understand that while generative AI can be a powerful ally in their educational journey, it has flaws, such as occasional inaccuracies or a lack of context in generated content. This viewpoint helps people use AI wisely and thoughtfully. It ensures that AI enhances their learning while they stay informed about how technology works.

The 'Practitioners' cluster shows a measured and neutral perspective towards generative AI. Members of this group engage in the technology, but they exercise restraint in their application of it. This cautious approach is rooted in a deep understanding of the limitations inherent in generative AI, as well as a recognition of the potential negative consequences that could arise from an over-dependence on such technology. They are particularly concerned about how relying too heavily on generative AI might compromise the quality of their graded activities or outputs, which are often critical for their assessment and professional development. Although they are open to experimenting with the capabilities of generative AI, members of the Practitioners cluster maintain a healthy skepticism. They value their own critical thinking skills and expertise and are reluctant to allow the technology to supplant their judgment or creativity entirely. As a result, they integrate generative AI into their work selectively, using it as a supportive tool rather than a replacement for their skills and analytical abilities. This balance allows them to benefit from technological advancements while still honoring the importance of personal input and critical evaluation in their work.

The 'Cautious Experts' group includes individuals who are skilled at understanding the strengths and weaknesses of generative AI technologies. These students know a lot about what generative AI can do, such as writing text, creating images, and helping with problem-solving. However, they approach these tools with caution, especially in academic settings. They are mindful of the limitations and risks of relying too much on AI-generated content, which can lead to misinformation, overdependence on technology, and a loss of original thought. Because of this, they pay close attention to how using AI affects their academic integrity to ensure their work remains high-quality and authentic. These individuals strive to balance the advantages of technology with careful consideration of ethical issues and the importance of critical thinking in their studies.

To effectively harness the immense potential of generative AI in the field of education, it is vital to tailor strategies that cater to the diverse profiles of students. Recognizing that students have varying interests, skills, and levels of comfort with technology, we can categorize them into specific groups and design interventions accordingly.

For students classified as "Enthusiasts," who are often eager to explore and push boundaries, implementing advanced training programs can significantly enhance their capabilities. This could involve offering challenging AI-integrated assignments that stimulate their intellect and encourage innovative thinking and creativity. Providing opportunities for collaborative projects where they can apply AI tools to real-world problems can further optimize their skills.

In contrast, "Practitioners," who may be more focused on applying their knowledge in practical scenarios, benefit from a balanced approach. This involves a mix of foundational training and opportunities to use AI as a complementary tool in their studies. For them, learning how to merge AI technologies with traditional methods effectively can enhance their problem-solving capabilities and prepare them for professional environments where such skills are increasingly relevant.

"Cautious Experts," on the other hand, approach AI from a critical standpoint and require targeted development of their abilities in critical thinking and ethical considerations. Programs designed for this group should emphasize the importance of evaluating AI outputs critically, understanding biases inherent in AI systems, and discussing the moral implications of technology in society. Workshops and seminars on these topics can provide invaluable skills that empower these students to become informed users and evaluators of AI technologies. To successfully integrate AI into the educational system, it is also crucial to establish comprehensive support systems. This includes acquiring paid or free licenses to technological platforms with AI integration, providing training for educators, and creating learning spaces where students are encouraged to experiment with AI tools.

Based on the clustering results, most students are aware of generative AI's capabilities to produce images, reports, and other resources for academic purposes. However, some may overlook the importance of considering the ethical implications associated with using generative AI. Addressing these ethical concerns is essential to prevent harm, ensure fairness, build trust, protect privacy, and maintain accountability. Establishing clear ethical guidelines can help mitigate risks such as misinformation and bias, foster trust among users, and respect privacy rights. It is crucial to emphasize the importance of these guidelines, particularly by integrating them into curricula so that all stakeholders understand the responsible use of AI. Additionally, robust feedback mechanisms should be implemented to enable students and educators to share their experiences, challenges, and successes in using AI for learning.

To foster a culture of responsible AI usage among students, the educational institution can implement awareness campaigns through workshops, seminars, and interactive sessions, highlighting best practices and cautionary tales. Informative sessions can include curriculum modules, case studies, and hands-on projects focused on ethical AI development. Cultivating a positive environment involves collaborative learning, mentorship programs, and feedback mechanisms. Empowering students can be achieved by offering skill development courses, career guidance, and innovation labs. These multifaceted recommendations will help students leverage generative AI to enhance their learning experiences and prepare them for the future workforce. As reported by learners usually ensure that online learning platforms meet their study needs and are relevant to their learning process before using them.

For future studies, it would be beneficial to triangulate the self-reported engagement measures of participants with behavioral tracking data and teacher evaluations. This

approach will provide a more comprehensive understanding of student engagement and help validate the profiles generated by the two-stage clustering method. By integrating these diverse sources of information, researchers can enhance the accuracy and reliability of their findings, ultimately leading to more effective educational interventions and strategies for improving student engagement. Research may also be undertaken to evaluate the effects of students' utilization of generative AI on their academic performance across multiple terms. This investigation aims to incorporate the role of student profiles in the effective integration of AI tools, thereby contributing to enhanced academic outcomes and the development of a robust theoretical framework.

CONFLICT OF INTEREST

The author declares no conflict of interest.

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